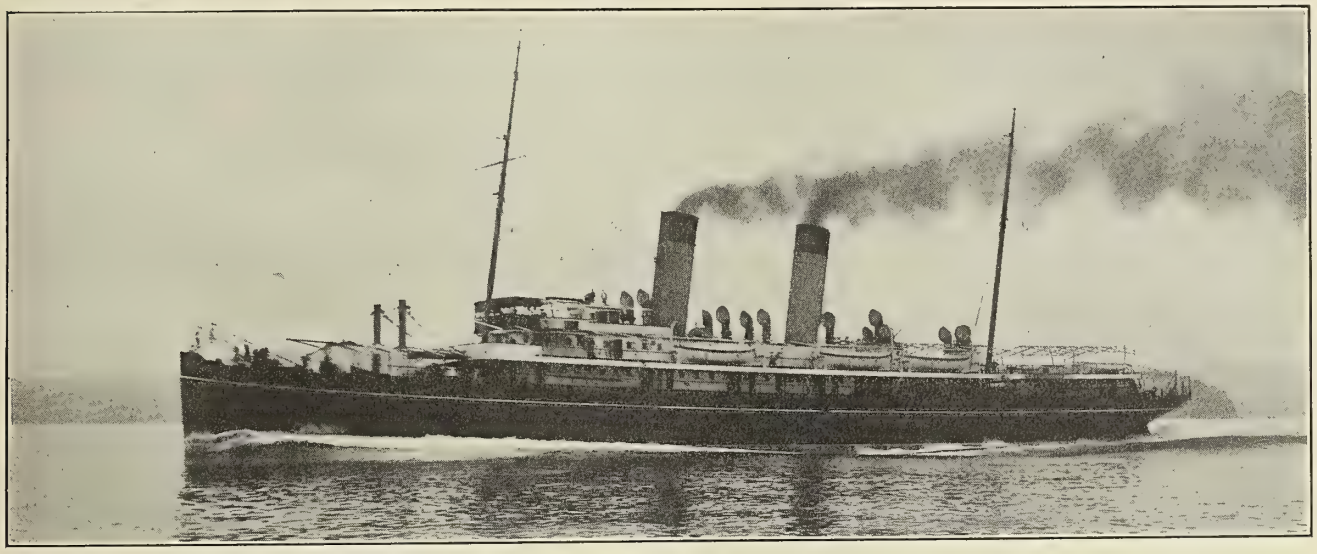
International Marine Engineering

MARCH, 1910.

THE SECOND TURBINE STEAMER FOR THE JAPANESE VOLUNTEER FLEET.

The experience gained with the first Japanese volunteer steamer *Sakura Maru*, built over a year ago, has been of much value to the Imperial Marine Association, which is the organizer of the volunteer fleet, and in the building of the second steamer, *Umegaka Maru*, every effort has been made to make her most useful, both in peace and war, having none of hermaphrodite fancies, which existed to a certain extent in the first steamer, nevertheless having every provision for ready transformation into a useful implement of naval warfare. She is a handsomely fitted and well-appointed vessel, and was designed and built at the largest private shipbuilding and engine works in the East, the Mitsu-Bishi Dockyard & Engine Works at Nagasaki, Japan. Her first keel plate was laid July 15, 1908, and she was delivered July 6, 1909, to the Imperial Railway Bureau, under whose management she will be run between Japan and Corea.

Mild steel was used in the construction, and great attention was given to the strength of the scantlings, which are greatly above the average for vessels of cross-channel type. The vessel also fulfils the requirements of Japanese shipbuilding and ship surveying regulations, and is subdivided below the main deck into thirty-six watertight compartments forming double bottoms, peak tanks, holds, oil bunkers, deep tanks, fresh-water tanks, engine and boiler rooms, steering-engine room, etc., which make the ship practically unsinkable, even if one or two compartments are flooded.



THE TURBINE STEAMER UMEGAKA MARU OF THE JAPANESE VOLUNTEER FLEET.

The *Umegaka Maru* is a triple-screw turbine steamer of the following dimensions and particulars:

Length between perpendiculars	335 feet
Breadth molded	43 feet
Depth molded	30 feet 6 inches
Gross tonnage	3,200 tons
Draft	16 feet
Indicated horsepower	8,500
Speed	21 knots
Number of special first class passengers	2
Number of first class passengers	34
Number of second class passengers	81
Number of third class passengers	347

MAIN AND AUXILIARY MACHINERY.

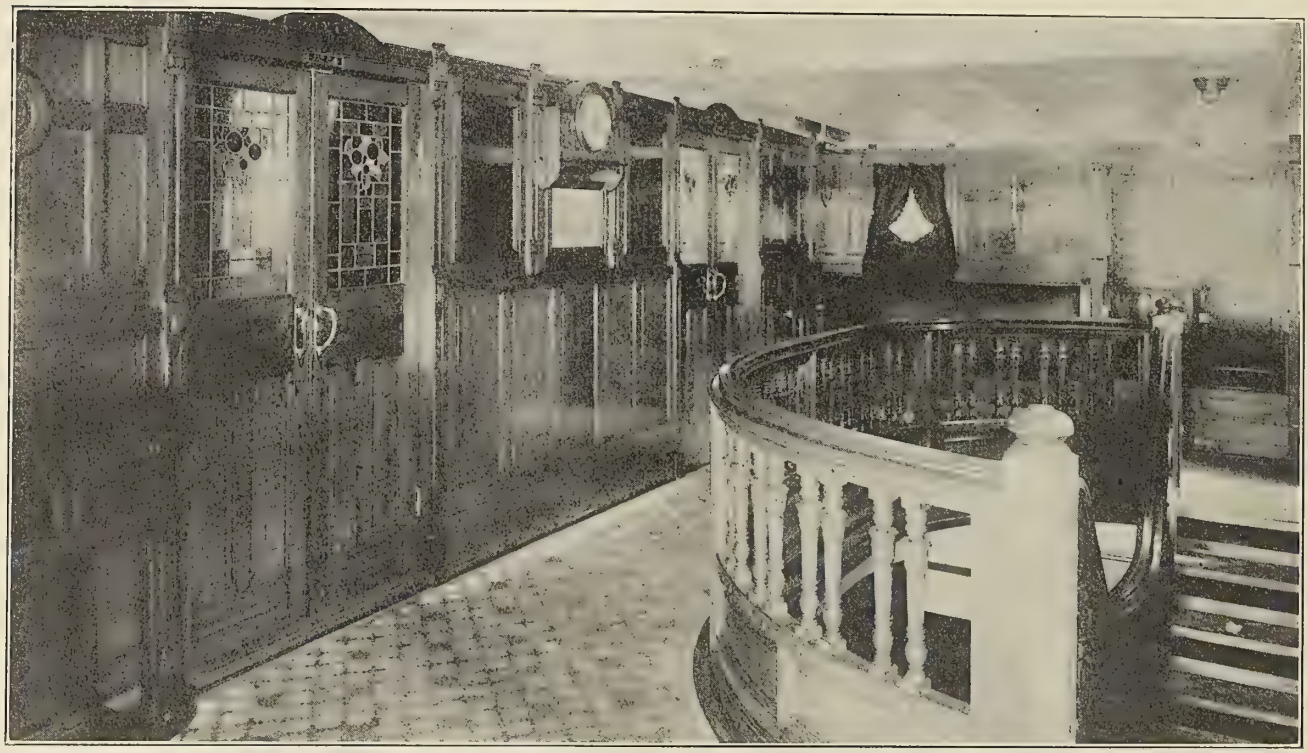
The propelling machinery, consisting of three sets of turbines of the Parsons type, was designed and manufactured by the Mitsu-Bishi Dockyard & Engine Works. The high-pressure turbine is on the center line, and one low-pressure turbine incorporated with an astern turbine on each of the wing shafts. The propeller shafting is of steel turned all over, and two plummer blocks are fitted to each length of shafting. The propellers are of the solid type and are of Stone's manganese bronze, accurately polished all over, so as to reduce vibration and friction to a minimum.

The handles of all valves for the ahead and astern turbines are accessible from the starting platform at the forward end of the engine room, so that one engineer can have complete control of all the machinery. The condensers of Morrison's Contraflo type, of which the Mitsu-Bishi Dockyard & Engine Works is the licensee, are placed alongside the aft ends of the low-pressure turbines and are built of steel plates, with strong cast-iron end chambers, with ample cooling sur-

face, and so arranged that the circulating water passes twice through the condensers entering at the bottom. Each condenser is connected to one of the low-pressure turbines by a large steel eduction pipe. The cooling water is supplied to the condensers by two large centrifugal circulating pumps, each pump having a connection of about half the area of the delivery to circulate water through the condenser on the other side when one of the pumps is disabled.

The vacuum system includes Weir's wet-air pumps and Parsons augmentor condenser, and these, together with circulating pumps, are designed to insure the maintenance of the high vacuum necessary for the economical working of the turbines. There are two wet-air pumps of the twin type, and the supply of power to fans and machines are placed at the aft end of the engine room. Of these we shall deal later in connection with the passenger arrangement.

There are four double-ended boilers of the Miyabara patent watertube type, designed for a working pressure of 200 pounds per square inch. These are arranged in two boiler rooms, and there is also a donkey boiler of the cylindrical type for auxiliary purposes in the aft boiler room. There are two funnels, elliptical in section, 76 feet 6 inches high, above the level of the firebars. These are double, the space between the outer and inner funnels being utilized for the ventilation of the boiler rooms and stokeholes. The boilers are worked under forced draft on the closed stokehole system, the air



MAIN STAIRWAY OF THE UMEGAKA MARU, SHOWING STYLE OF INTERIOR DECORATION OF THE VESSEL

these are fitted at the forward end of the engine room, one on each side of the center line.

Pumps are also supplied for forced lubrication of the bearings, and for oil-cooling purposes. There is a full complement of pumps for the bilge, sanitary and fresh-water service of the ship.

There are two pairs of Weir's double-acting feed pumps, each pair being capable of supplying the boilers when the turbines are exerting their full power. They are so connected that either pair may deal with the turbines. These pumps are arranged to draw from the hot wells through the float tank, condensers, feed tanks, boiler bottoms, fresh-water tanks and drain tank, and are fitted in the forward end of the engine room, together with a feed heater of the surface type and feed-water filters of the gravitation type. An auxiliary condenser with independent air and circulating pumps is also fitted at the forward end of the engine room.

The distilling plant consists of two evaporators capable of producing at least 30 tons of water per 24 hours, and two distillers capable of making about 10 tons of pure water per 24 hours.

A workshop is supplied with one lathe, one drilling machine, one shaping machine, one grindstone, etc. All these machines are driven by electric motor.

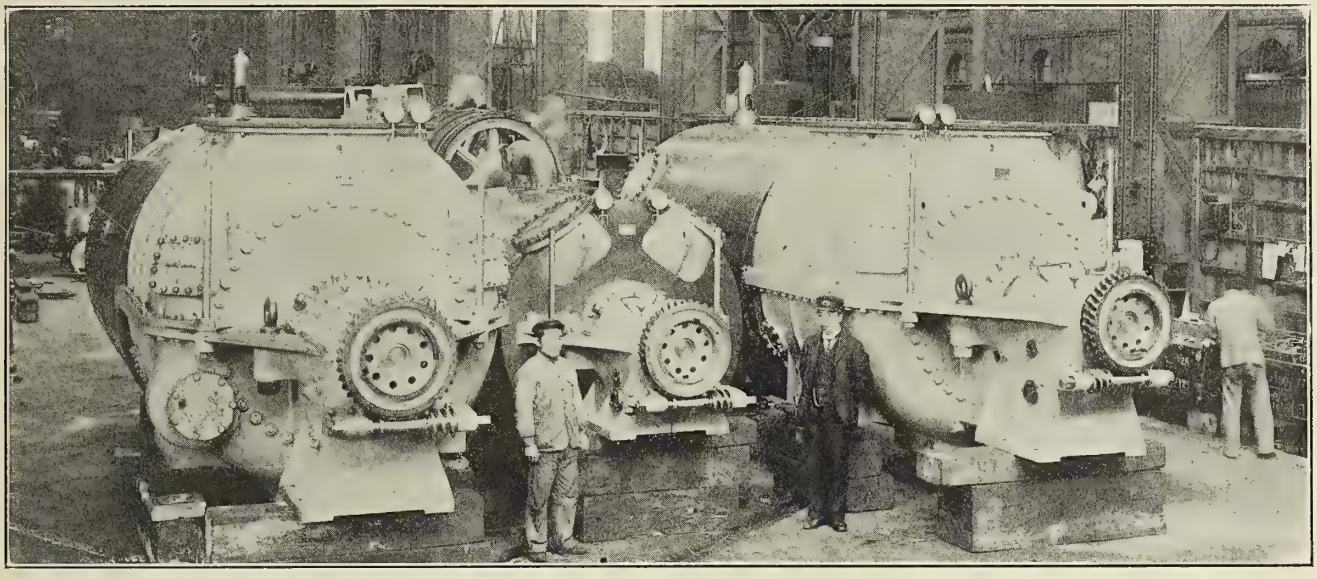
The engine and dynamos for the lighting of the ship and being supplied by four fans, each driven by one double-acting steam engine. One air compressor is fitted for tube-cleaning purposes.

The Miyabara double-ended watertube boilers consist of three water legs, forming two combustion chambers between them, one on each side of the middle water leg. Each leg is composed of three horizontal cylindrical drums, arranged one above the other, connected together by short tubes, and a series of diagonal tubes connecting the three legs and crossing each other over the fire-grate. Within the three middle drums, and enclosing the ends of the two groups of generating tubes which meet therein, diaphragm junction boxes are fitted for the purpose of separating the upcast water rising through the generating tubes from the downcast water running down from the top steam drum to the bottom water drum, thereby preventing interference between the upcast and downcast circulating water. A steam dome is fitted over the three water legs and connected to their tops. The tubes are of mild steel, solid drawn and cold finished, and were tested to a hydraulic pressure of 1,000 pounds per square inch before being worked into place. The drums are made of mild steel. Each boiler is fitted with three furnace mouths at each end, and the furnace doors open inwardly, resting on horizontal spindles and fitted with balance weights. The ash-pit doors are so arranged that in the event of a tube bursting under steam,

they would close automatically. The whole is enclosed in sheet metal casing.

The boilers are fitted with a complete installation for burning coal and oil in combination. Körting burners are provided in conjunction with the Flannery-Boyde system of settling tanks. The oil is injected into the furnaces by means of mechanical pressure, being delivered by pumps to the burners. There is a full complement of oil strainers, oil heaters, oil feed pumps, pressure oil pumps, etc. A steam ash-hoisting engine and a See's ash ejector are also fitted in each boiler room.

Progressive endurance and full-speed trials were carried out with the vessel, her performance being exceptionally satisfactory throughout. On the full-speed trial she attained a speed of 21.3 knots as the mean of means of six runs on the measured 3-mile course, outside of Nagasaki harbor, the maximum speed being 21.575 knots. The speeds obtained in the six consecutive runs were as follows: 21.135, 21.465, 21.100, 21.538, 21.135 and 21.575 knots.



PARSONS TURBINES FOR THE UMEGAKA MARU, BUILT AT THE MITSU-BISHI DOCKYARD AND ENGINE WORKS.

GENERAL ARRANGEMENT.

The vessel is schooner rigged, with two pole masts fitted with the necessary derricks for the rapid handling of cargo; while her two large, oval funnels give her the appearance of a mammoth ocean liner in miniature.

There are five decks; the boat, shelter, spar, main and lower decks. At the forward end of the boat deck, which extends for about 240 feet amidships, there is a large deck house to accommodate the special passengers, and the navigating officers with a navigating bridge and chart room directly above. Six lifeboats are stowed on this deck, while the remaining area forms a promenade for first class passengers. Two boats, one gig and one tenma (native boat) are stowed on the aft boat deck, which forms a promenade for the second class passengers. All the davits are of Welin's patent quadrant type, the two pairs for lifeboats amidships being of extra strength, in order that one pair may be used for a steam pinnace weighing 7½ tons, and the other for a pinnace weighing 3½ tons.

The shelter deck forms the principal deck of the vessel. Large houses are constructed on this deck, the forward house containing first class staterooms and public rooms, the midship house containing cabins for the senior engineers, custom and health officers, and the aft house containing the second class dining saloon and hospital.

The main entrance to the first class accommodation is on this deck; the general design and paneling is of polished wainscot oak, and the floor is laid with interlocking rubber tiling. In the center is an easy stairway leading down to the spar deck, and two side stairways leading up to the promenade space on the boat deck. It is lighted and ventilated overhead with a large skylight decorated with stained glass.

Forward of the main entrance are the reading room and saloon. The decoration of the reading room is worked out in wainscot oak panels and framing, and the ceiling is finished in panels, painted in unglazed white and gilded. The furniture is also of polished oak, and sofas and seats are richly upholstered in heavy silk of dark green shade. The windows and doors are hung with rich silk curtains of the same shade as the sofas, and the floor is laid with Wilton carpet and runners. There is fitted an upright cottage piano from the Nippon Musical Instrument Factory; decorated and finished in oak in a manner to harmonize with the remainder of the room. Adjoining the reading room is the dining saloon. Seating accommodation is provided for thirty-four passengers arranged at small tables. The decoration is also in oak. The ceiling is paneled and painted in unglazed white and gilded. It is lighted by two skylights with stained glass, thus giving the room ample light and air overhead. The saloon is also lighted and ventilated by a number of large rectangular side lights, with silk hangings of dark crimson color. Sofa seats upholstered in silk of the same shade are placed round the sides of the saloon. There are two sideboards of polished oak at the ends of the saloon. The floor, which is of wood parquetry, is laid with Wilton runners and mats. Service is from a roomy pantry in close proximity.

In general the design of carving and stained glass in the reading room and saloon is based on the plum blossom, and is purely Japanese in style.

Aft of the main entrance and about the boiler casing there are first class staterooms, lavatories, smoking room and bar.

The smoking room is located between the boiler casings and extends the full breadth of the deck house. Here the paneling and framing are of fumed oak, and the furniture is also of fumed oak. A prominent feature of this room is a

large panel on the forward bulkhead painted by Mr. Giokusho Kawabata, member of Artisans for the Imperial Household. Small tables and chairs are comfortably arranged about the room. The upholstery is of dark brown morocco, and the hangings are of silk of similar shade. Overhead there is a large central skylight decorated with stained glass of Oriental Zodiacal design. The floor is of interlocking rubber tiles.

The forward portion of the spar deck is arranged for the third class passengers. Aft of this there is additional accommodation for first class passengers; midships the officers are quartered, while the aft part is entirely utilized for the second class passengers. The firemen are also berthed in this deck.

The second class dining saloon on the shade deck accommodates twenty-eight passengers. Its paneling and framing are painted white, with polished teak dado. The ceiling is also paneled and painted white. It is lighted and ventilated by a large overhead skylight. The furniture is of polished teak. A small pantry is fitted at the aft end. Aft the dining saloon there is an easy stairway leading down to the sleeping accommodations on the spar deck.

The third class passengers are berthed partly on the spar deck and partly on the main deck. The greater portion of the third class space on the spar deck is occupied by the lavatories, etc. The berths are of wood on galvanized iron framing, common to those steamers trading in Eastern waters.

Purser's, doctor's, engineers', chief steward's, cooks' and stewards' rooms are arranged midships. Near the purser's room and below the main stairway there is a specie room in which valuables can be carried. It is substantially built of steel, with a strong door fitted with Chubb's patent locks. Adjoining the doctor's room is a dispensary and then an officers' mess room; those three rooms are accessible to each other, thus providing the means of turning the mess room into a sick bay when required, and for this purpose the deck is specially insulated and cemented.

A telephone room is annexed to the clerk's office at the end of the officers' quarters, which is so arranged that while the vessel is lying at a wharf it may be connected with the city telephone for general communication.

Forward of the second class space is a large mail office and postmaster's cabin. The mail room is completely fitted out to meet the requirements of the Imperial Post for sorting mails en route. The furniture is of polished teak. The main deck, forward, is arranged for third class passengers, while at the extreme end are the crew's quarters. Mail rooms, mail clerks and apprentices are located at the aft end, while the midship portion of this deck is entirely taken up by the machinery.

The forward lower deck is arranged for various stores and the after one for cargo space.

There are many notable features in connection with the sanitary arrangements, for baths are fitted for all classes of passengers, and for the officers and crew. Those for the first class passengers and officers are fitted with showers and heaters, and those for third class passengers and firemen with heaters. A considerable number of hot-water boilers and hot-water heaters with steam and water connections are distributed over different parts of the ship. Expensive as all these arrangements are, they insure perfect sanitation for the vessel. All sanitary apparatus is supplied by Messrs. Shanks & Co.

A complete refrigerating plant by Messrs. Hall & Co. is fitted for the preservation of fresh provisions. The cold chamber is subdivided into four compartments, having a total capacity of over 1,200 cubic feet. It is also arranged to make 336 pounds of ice daily without interfering with the cooling of the chamber.

For electric light and power there are two sets of engines and dynamos together, capable of developing 60 kilowatts, each set being capable of generating and supplying light equal to 6,424 candlepower, and of supplying the necessary current for three cluster cargo lamps of 200 candlepower each, for all signal lamps, for the workshop machines, and for forty-six electric fans. The engines are of the self-lubricating condensing type, running at about 350 revolutions per minute. The dynamos are of 100 volts and six-pole compound wound. Both sets are placed at the aft end of the machinery space on the main deck. The current is transmitted by insulated cable of high conductivity; all wiring being done on the double-wire distributing box system. A marble switchboard is fitted in the dynamo room, from which the mains are led to their respective junction, switch or distributing boards throughout the ship. The masthead, side and stern lights are fitted with 32-candlepower lamps, with an indicator placed in the chart house to show when they are burning. The engines and dynamos are of the builder's own make.

Electric bell communication is provided to all staterooms and senior officers' rooms. A telephone of Graham's marine type is fitted between the navigating bridge and engine room.

For ventilation each compartment has outlet and inlet ventilators. Twenty-one large overhead electric fans are distributed through the public rooms, and over twenty-five bracket fans to the staterooms and senior officers' rooms and a large exhaust fan to the dynamo room.

The steering gear of Messrs. Caldwell & Co., with telemotor and shaft gear, is placed in the lower deck, with an emergency steam gear on the main deck. The gear is actuated from the navigating bridge, also from the steering station at the aft end of the boat deck. A capstan of the same make is fitted on the shelter deck and worked by means of shafting and gear from the emergency steam gear.

The steam windlass is by Messrs. Napier Bros., and the cargo winches are of the builder's own make. Engine room, steering, docking, lookout and anchor telegraphs are of Messrs. J. W. Ray & Co.'s make, while the electric direction tell-tales are supplied by the Tokyo Measuring Instrument Factory. An innovation of Walker's patent Neptune electric ship log is seen in the ship.

ENGINEERING EDUCATION IN THE NAVY.*

The education of naval officers in engineering to provide for the demands of the service starts at the Naval Academy. There, as a foundation, all line officers are given what is probably the best technical education furnished by any school in this country. This tribute to the Naval Academy is based upon the method of selection of the student and upon the method of elimination of the student at the school, quite as much as upon the excellent system of technical education that has been developed within the last half century and that has been particularly improved within the last ten years. The Naval Academy is still being improved, and it is to be hoped that progress will not cease, but to-day it is considered by the bureau and, what is more to the point, by many skilled educators, to be the finest school of engineering in the country.

The graduates of such a school are naturally fit to undertake subordinate engineering duties of all sorts, and that is what they get, one and all. For five years, or until they have been promoted above the grade of ensign, they perform duties, under the naval regulations, alternately on deck and in the engine room. Whatever their duty is named, it is engineering duty in fact. Almost every act of the line officer has to do with machinery and with engineering. This may be direct, as

* From the annual report of H. I. Cone, engineer-in-chief, United States Navy.

when his duties involve maintenance of the machinery plant, or it may be indirect, as when his duties involve the executive duties of handling a ship, or of directing men that are directly engaged in handling the mechanical appliances of such widely varied sorts as are found on our vessels. The line officer lives, as may be said, in a heavily charged engineering atmosphere, and in actually performing his duties in gunnery and in electricity, he is constantly directing the operation of complicated machinery, and is conversant with the average mechanical problem. By training and by the constant exercise of authority he is an excellent administrator, and by profession he is a directing influence to those under him. Through his general experience, the line officer possesses one qualification which no other officer in another corps or branch of the service could possibly attain, namely, the knowledge of and appreciation of the aims of his superiors from a military standpoint. In other words, he is vitally interested that his ship shall be in condition to meet any call from his captain or his admiral, with a knowledge of the nature of the requirements born from constant speculation as to what he will do when he becomes captain or admiral.

This continuous performance of engineering duty, using the term in an engineering sense rather than in the service one, fits the line officer for the superior duties of senior engineer of our vessels. The bureau wishes definitely to state that the problem confronting it does not include the keeping of the motive machinery of the fleet in condition, for that has been solved, and there are to-day a sufficient number of line officers fully competent to fill the position of senior engineer officer. This fact is evident from the present superior mechanical efficiency of our vessels in commission; from the decreased proportionate amount of the repairs necessary for the maintenance of the ships' machinery in good condition; from the increased proportion of repairs incident to the service that are being performed by the ships' force; and this with increased strains on the machinery, due to their now being more frequently operated at or near their designed power than has formerly been the case. The credit for this performance belongs in various quarters. Great credit is due the enlisted personnel, and in particular to those of them that have evidenced such energy and ability as to secure appointment as warrant officers. Obviously, however, the main credit is due to those responsible officers who have had charge of the machinery, and to their immediate official subordinates. These have proved their worth, and they have justified the legislation of 1899 that made all engineers line officers and that made all line officers engineers. It is now generally recognized throughout the service that the latter truth was as much a result of the personnel law as the former one. All officers lean upon the expert engineer's knowledge in developing improvements in any branch of naval efficiency. It will be found to-day that former engineer officers are occupying positions of high responsibility under every line bureau of the department, and that many officers who never received any special engineering education are performing with eminent success duties under this bureau.

There is one branch of engineering that this excellent general education does not fully qualify all naval officers to perform: The important work of designing the machinery of our vessels. When the personnel law was passed, the Congress provided for the needs of the service so far as expert designing engineers are concerned, by reserving a certain number of the old engineer corps exclusively for engineering duty. It was foreseen at that time that this was a temporary expedient, sufficient for the needs of the immediate future, but not sufficient to provide for the then comparatively remote time when the officers of the old engineer corps reserved for engineering duty only should pass from the active list of the officers of the navy. No direct provision to cover future needs of the service was made in the personnel law of 1899, but ample authority was left with the Secretary of the Navy to solve this question through his power to detail officers to such duty as he deems most desirable.

Successful, efficient, safe operation of machinery can only result from competent and careful design. The successful cruise of the Atlantic Fleet around the world is as much a tribute to the excellent work of the older engineers who designed the machinery of that fleet as to the efficiency of those that handled the machinery. It is essential to future success that we have competent, expert designing engineers to do the work that the older engineers so efficiently performed in the past. Now, by definition, the expert is a man who is generally well qualified in all branches of his profession, but who devotes his entire attention and directs his whole effort along some one line of that profession. That the designer of a marine engine must be an expert in order that his design may be entirely successful cannot be doubted. Therefore, we must have at all times a limited number of officers in the navy who devote themselves exclusively to scientific engineering. This accords with the expressed opinion of the personnel board of 1899, that some specialization for the design and inspection of machinery should be created.

Since the passage of the personnel law of 1899, every engineer-in-chief has seriously advocated some method of securing special training for a small number of officers to provide for the time, now comparatively near at hand, when the designing and other scientific engineering work must be done by others than officers of the old engineer corps. All have advocated some school of engineering. It has been the good fortune of the present chief of this bureau to reap the benefit of the plans of his distinguished predecessors, and to propose to the department a plan for the creation of such a school of marine engineering that has been adopted and that will, it is believed, provide for the needs of the service in the future.

The principal object of the recommendation favoring such a plan was to secure an adequate, but small, number of thoroughly well qualified engineering experts to perform designing engineering work for the navy. To reap the full benefits of the personnel bill and to secure the very best future designs, it is, in the bureau's opinion, an essential qualification that these officers should be all-round naval officers of ample general experience, to enable them properly to adapt naval machinery to the requirements of the service. This implies several years' experience at sea, and it also implies the performance by all of these officers, at some time previous to their selection as designing engineers, of that sort of duty commonly called line duty, namely, executive duty, concerned with the ship as a whole as a unit in the fleet. Some such duty is essential to that clear and broad conception of the requirements of the service that it is essential should govern all designs of naval vessels and of naval machinery.

Ten officers have been selected from applicants for this duty for detail to the School of Marine Engineering. These officers have had at least three years' sea service, and have been selected according to their evidenced capacity. Provision is made for the selection of officers for designing duty from among those specially well qualified by education, experience and inclination, pending the time when graduates of the school will be eligible for such detail under the terms of the order.

The headquarters of the School of Marine Engineering is fixed at Annapolis, in accordance with the bureau's recommendation. This recommendation was made after careful investigation and consideration of the advantages of various private institutions of learning.

The annual meeting of the Institution of Naval Architects will be held March 16, 17 and 18 in the Hall of the Society of Arts, John street, Adelphi, London, W. C. The Right Hon. Earl Cawdor, president, will preside.

ORE-HANDLING EQUIPMENTS FOR LAKE VESSELS.*

BY RICHARD B. SHERIDAN.

MODERN UNLOADING MACHINERY.

With the introduction of the grab bucket there have been practically but two types of machines developed: One, that employing a bucket suspended by the operating ropes, and the other a grab bucket carried on a rigid arm. The first type is shown in Fig. 5, and the other type in Fig. 6.

The machines shown in Fig. 5 are unloading plants built for the Pittsburg & Lake Erie Dock Company, at Fairport, Ohio, and the equipment consists of six units. Generally each of these units consists of a structural steel pier mounted on double-track equalizing trucks, and each truck carried on four double flanged, chilled tread wheels. Each pair is designed to carry a traveling hopper or chute, designed to deflect the ore into the railway cars running beneath the same. An apron extension it attached to the main runway on which the trolley operates, and designed to project over the vessel. This extension is made so that the same may be raised and lowered to facilitate boats coming into dock. At the rear end generally a cantilever projection is arranged so that the ore may be dumped into a stock pile at the rear, for the purpose of rehandling into cars or into a more permanent stock pile as the case may be. The machines are designed to be moved along their supporting rails by power, the moving-gear mechanism being located in a small house above the trolley track or runway. From this mechanism, shafting and gearing transmits the motive power to each of the supporting truck wheels, thereby allowing the machine to be moved along its supporting rails at the will of the operator.

The man trolley on each machine consists essentially of a steel frame, mounted on track wheels and arranged to run on the structural steel runway of the pier. The trolleys are made self-propelling, the method of moving being by wire ropes attached to each end of the runway and passing over a drum located on the trolley frame. By this method the trolley can be accelerated very quickly and stopped quickly, which would not be the case with trolleys operated by the tractive force of the supporting wheels. To the trolley is attached the operator's cage, from which point the operator controls all of the motions of the machine. The hoisting mechanism operating an 80 cubic feet grab is carried on a turntable, located within the trolley frame, and by this arrangement the bucket may be turned through an angle of about 180 degrees. This feature allows the bucket to be turned so as to open fore and aft of the vessel and thus reach in under the deck between the hatches. The length of the bucket open is such that in boats whose hatches are 12 feet centers, the bucket when working in adjacent hatches will reach in past the center of the ore lying under the deck between the hatches, the whole purpose of this arrangement being to reduce, as far as possible, hand labor within the boat.

The electrical equipment in one of these machines consists of two 125-horsepower motors for hoisting the bucket, one 100-horsepower motor for racking the trolley, and one 3½-horsepower motor for rotating the bucket. The machine is propelled along its supporting rails by a 75-horsepower motor.

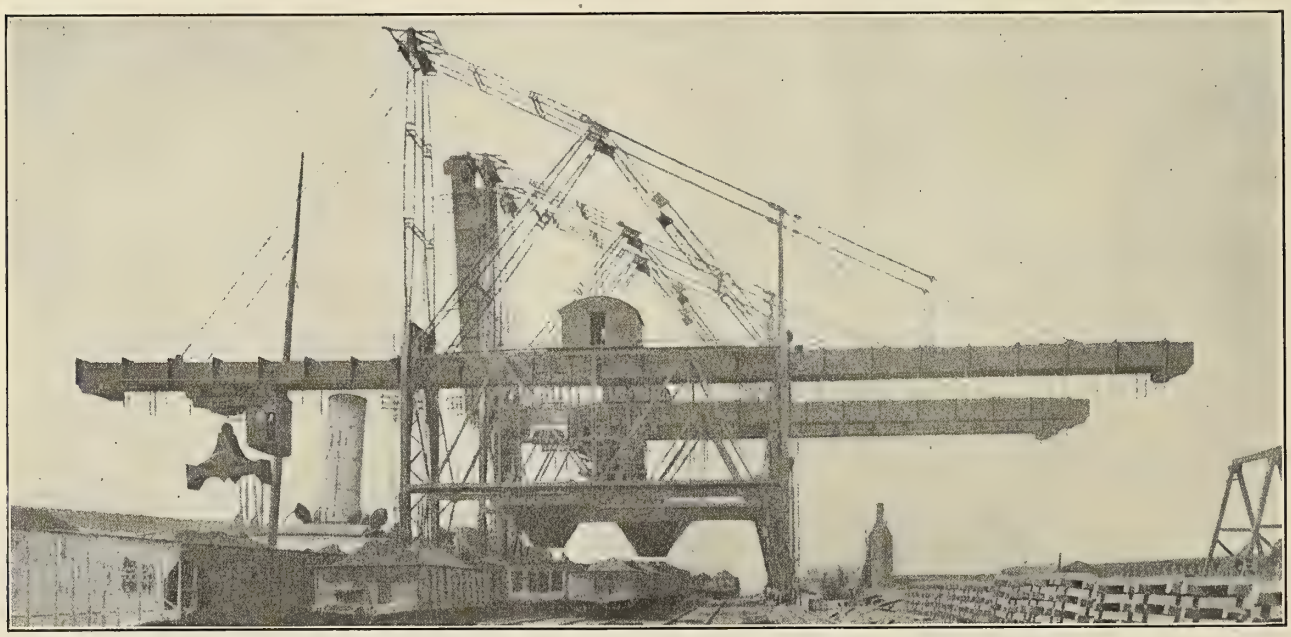


FIG. 5.—FOUR ELECTRIC HOIST PLANTS, PITTSBURG & CONNEAUT DOCK COMPANY, CONNEAUT, OHIO.

With the above electrical equipment the speeds of the various functions range about as follows:

Hoisting, 300 feet per minute; trolley, travel, 800 to 900 feet per minute; machine travel along the supporting rails, 75 to 100 feet per minute.

The main dimensions of the machines now used of this type are approximately as follows:

Span of pier, 62 feet 10 inches; cantilever projection over the water, 59 feet 3 inches from center of shear leg next to waterfront; cantilever projection at the rear, 100 feet from center of rear shear leg; height of runway above supporting tracks, about 44 feet; total hoist of bucket, about 74 feet.

The moving-gear mechanism is arranged with a solenoid brake, designed so that when no current is passing through the motor the moving-gear mechanism of the machine is locked. The hoisting and lowering of the bucket from the trolley is controlled by a powerful foot-band friction brake, and the racking motion of the trolley is controlled by an independent band friction brake.

There have been many different proportions of machines of this character, but the type shown in Fig. 5 is the one generally used.

* Concluded from the February issue.

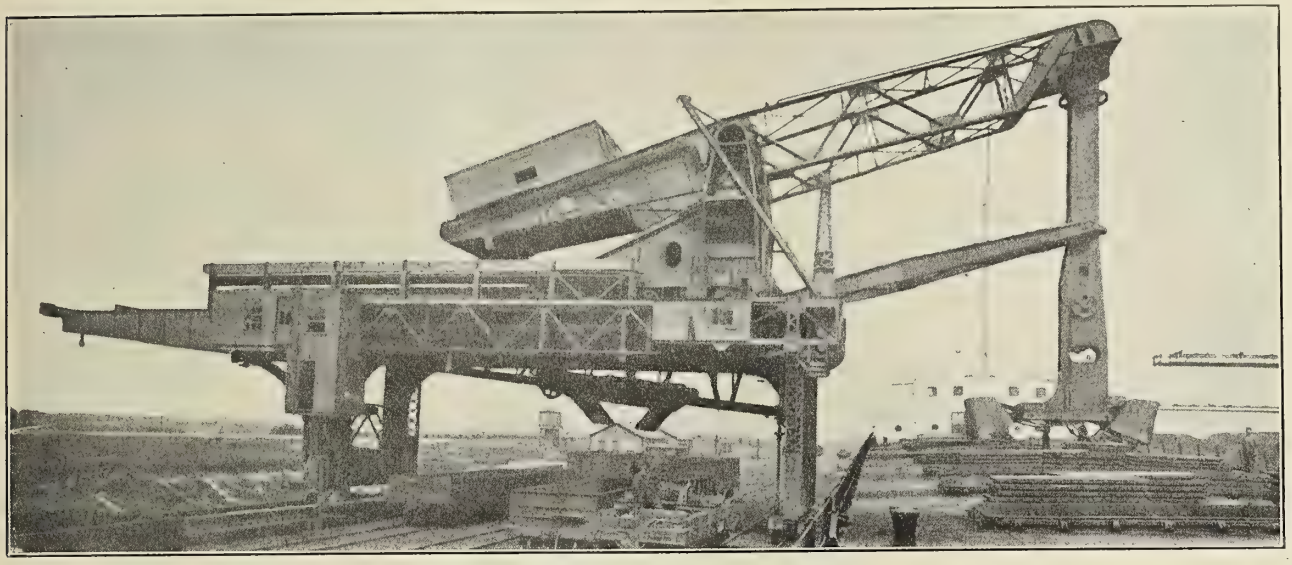


FIG. 6.—GRAB-BUCKET CARRIED ON A RIGID ARM.

A similar type of machine arranged with no cantilever at the rear, but equipped with a 200-ton weighing hopper or bin, in the pier itself to take the place of the small deflecting chutes and designed to weigh the ore or material directly into railways cars running beneath is sometimes used. Machines of this type are particularly advantageous on docks where ore is handled directly into cars for shipment. In general the machine is the same as that of the other type.

The weighing bin is an interesting feature. It is rectangular in plan, being 27 feet 4 inches long by 18 feet 6 inches deep. Its sides and ends are curved to a parabolic form, so that the bin is like a huge bag. It is carried from the pier structure through a set of specially designed scales, the method of suspension of the bin being from the four corners by rods. In the bottom of the bin are two chutes, each being 2 feet wide by 7 feet long. These chutes are arranged in the bin so that both will dump into the same railway car lying beneath. The chutes are each arranged with an electrically operated gate, the two gates being so arranged that they will work simultaneously when opening and closing. The closing edge of the gate is cut away in a V-shape in the middle and tapering off towards the ends. By this arrangement the stream of ore passing through the chutes may be gradually cut down to nothing, the purpose of the indentation in the closing lip of the gate being to reduce the stream more gradually than it could be if the whole 7 feet had to be figured on. The bin weighing mechanism is fitted with plus and minus weighing beams, so that the ore going into the bin is continually noted, and likewise the ore drawn off is easily weighed and kept track of. The whole design of this bin, its method of suspension and the scale feature is one which would constitute a paper in itself, and therefore I am obliged to pass over it with this very meager description.

Machines of this type, with 5-ton buckets, have no difficulty in handling ore, from the modern lake vessel with hatches spaced 12 feet centers, at the rate of 400 to 425 tons per hour when breaking into a hatch, and there are many records where boats of modern dimensions have been unloaded by a plant of these machines at the average rate of 319 tons per hour per machine, and at a power consumption varying from .35 kilowatt hour per ton of ore handled to .5 kilowatt hour per ton of ore handled, this variation de-

FIG. 7.—FIVE BRIDGE TRAMWAYS FOR UNLOADING ORE FROM A BOAT DIRECT TO THE STOCK PILE AT A FURNACE PLANT.

pending upon the class of boat unloaded and the efficiency of the operators.

The unloading machines above described have met all of the various conditions to be overcome in handling ore from boat to railway car. The question of handling ore from boat to stock pile has been taken care of in two ways.

Where the stock pile is at a furnace plant and is drawn from for that purpose, a type of machine similar on general principles to the first unloading machines has been developed. This type of machine is shown in Fig. 7. Each of these machines consists of a bridge span with an apron projection over the water and supported on one end by a pier and on the other by a shear leg. The entire structure is mounted on wheels and arranged to be moved along the supporting rails at the will of the operator. In place of having the operator at some fixed point, as in the early types, he is arranged to travel with the trolley in the same manner as on the fast plants described above. In general, machines of this type are but lengthened-out fast plants and serve the same purpose, but on account of the longer run of the trolley, the capacity per hour from boat to stock pile is somewhat reduced.

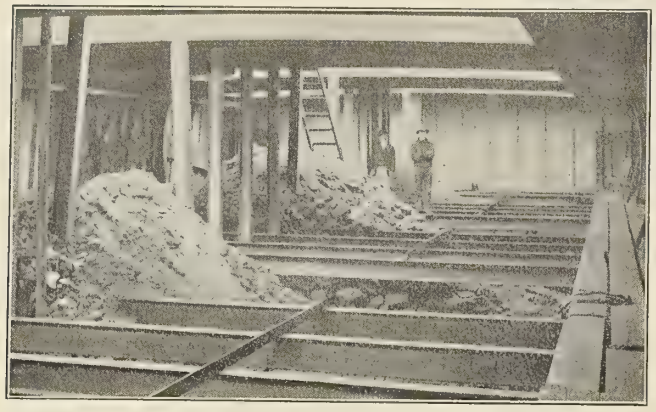


FIG. 8.—HOLD OF OLD-TYPE ORE VESSEL, HATCHES SPACED 24 FEET CENTERS.

Another very popular and economical method of handling material into stock has been used by many of the dock companies. The arrangement consists of a battery of fast plant unloaders at the water front and cantilever projections at their rear. And then in connection with these machines a separate stocking bridge of larger capacity is arranged to take the material from the pile made under the cantilever projection at the rear of the fast plant.

The other type of unloading machine is commonly known as the "stiff leg" and is shown in Fig. 6. It was invented by Mr. G. H. Hulett, of the Wellman-Seaver-Morgan Engineering Company. These machines have been built with buckets having a capacity of 10 and 15 tons. They were originally designed to be controlled by hydraulic power, but since the first machines they are now being built for electric control throughout. It may be stated that they form a distinct class of their own, and while there are several different designs made to suit special conditions, the following applies to all of the stiff-leg unloaders.

The machines consist in general of a bucket mounted on the lower end of a vertical rotating bucket leg, which is supported by a walking beam and always kept in a vertical position by a parallel arm to the walking beam. The walking beam is carried from trunnions supported by a mast on the front end of a trolley frame, which travels back and forth on a pair of girders forming the span of a gantry frame. The gantry frame is set at right angles to the face of the dock and arranged to travel along the same on tracks running parallel to the dock front. On the gantry frame, over the railway tracks, is arranged a movable transfer car, designed to receive the material from the bucket, and this transfer car dumps the contents into cars directly beneath on any one of the several tracks running along the front of the dock. The various functions of opening, closing and rotating the bucket and racking the trolley are accomplished by an operator situated in the bucket leg directly over the bucket.

The bucket itself is made up of two separate scoops, the same as is generally found in the ordinary grab bucket. These scoops or plates are carried on wheels, which are arranged to run in predetermined paths on the end of the fixed bucket arm and are further operated by bucket arms, which are connected in the present machines to electric motors placed on the rear of the walking beam. The arrangement is such that the operator located in the end of the bucket leg can control the opening and closing of these bucket blades. One of the blades in this type of machine has only a rotating motion, while the other one has a rotating and scraping motion. By this method the entire opening or reach of the bucket is obtained by one blade, which throws the system off the center of the rigid bucket arm, the purpose of this eccentricity being to accomplish a long reach under the deck between hatches. This feature, along with the rotating feature of the bucket arm, gives the machine an easy control in securing the load for the bucket. After securing a load, the entire bucket and arm is raised vertically with the parallel motion above described, until the bucket is brought to a height sufficient to dump into the transfer system. The trolley carrying the walking beam is then traveled on the gantry structure carrying the same until the bucket has been brought over the transfer car where the load is dumped. The various functions of opening, closing and rotating of the bucket, together with the racking of the trolley carrying the walking beam, are accomplished by the operator in the bucket leg. Another operator controls the motions of the transfer car into which the bucket deposits its load. The walking beam carried on the bucket arm and bucket is, as can be seen, balanced by means of the machinery and a cast iron counter-weight at the rear end, so as to allow only a sufficient amount of unbalanced load to warrant the bucket taking its rated capacity. The trolley, which supports the walking beam, is carried at the front end by a pair of four-wheel equalizing trucks, and at the rear end by a pair of two-wheel trucks. The racking movement of the trolley is accomplished through a pair of spur pinions meshing with a pair of

FIG. 9.—HOLD OF THE WOLVIN, SHOWING FIRST RADICAL CHANGE IN CONSTRUCTION.

racks attached to the gantry structure. The pinions are driven through spur gearing from the moving-gear motor. On account of the center of gravity of the walking beam and bucket arm being in front of the trunnions supporting the same, the rear end of the trolley supporting this walking beam is provided with a pair of inverted trucks to insure equilibrium. Further, the travel of the trolley supporting this walking beam is provided with automatic stops to prevent over-travel. The hoisting motion of the bucket leg is limited in its upward travel by automatic electric cut-outs and a mechanical safety latch at the rear end of the walking beam, which is designed to hold the beam in case of extreme travel. All of the operating machinery is provided with solenoid brakes, which are set when the current is off.

The transfer car running beneath the trolley carrying the walking beam is racked back and forth by means of cables,

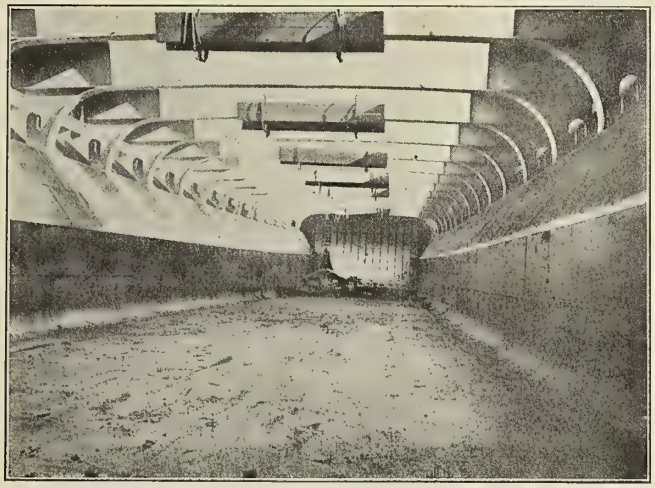


FIG. 10.—INTERIOR HOLD OF LATEST TYPE OF ORE CARRIER.

the mechanism for operating the same being located in a house in the rear of the machine and controlled by a separate operator, also situated in this house.

The electrical equipment on the latest machines of this type, which are located at Ashtabula, Ohio, and are rated as 15-ton machines, is as follows:

One 200-horsepower motor for raising and lowering of the bucket arm; one 100-horsepower motor for closing the bucket; one 25-horsepower motor for rotating the bucket arm; one 75-horsepower motor for traveling the walking beam trolley; one 25-horsepower motor for operating the larry gates; one 100-horsepower motor for moving the total machine along its supporting rails, and one 150-horsepower motor for operating the transfer larries.

This type of machine is much heavier than those of the suspended bucket type, and requires particularly heavy foundations, and as may be seen, more men to operate than the suspended machines described before. They further are not so designed that they may take out of stock, which, in some cases, is a disadvantage.

INFLUENCE OF GRAB ON SHIP CONSTRUCTION.

Fig. 8 is a view of the interior of one of the older types of ore-carrying boats, with hatches 24 feet centers. After the adoption of the grab bucket the various beams, stanchions, etc., were a great hindrance and caused delay in the rapid discharge of the material. The result has been that the hatches have been spaced about 12 feet centers.

Fig. 9 gives the interior view of one of the first radical changes in ship construction worked out. This picture is of the interior of the steamer *Wolvin*, which has a carrying capacity of about 12,500 tons. Her length is 560 feet over all, 540 feet on the keel, with a beam molded of 56 feet at the widest part and a molded depth of 32 feet amidships. At the time she was built she was considered novel, inasmuch as the cargo hold was of different form than that of any other boat built up to that time.

This was constructed in the form of a hopper with sides that sloped from the main deck down to the tank top, and the ends built on the same slope. This hopper extends in one continuous length 409 feet without bulkheads or divisions of any kind, and its width measures at the top 43 feet, and the bottom 24 feet. This construction was adopted so as to accommodate the use of the automatic clam-shells in unloading the cargoes, and while it serves the purpose it also serves to make a very strong and rigid vessel. Another feature in the construction of this boat is the fact of the ordinary stanchions being dispensed with, and in their place a system of girder arches are substituted to support the upper deck, as well as the sides of the boat. In her deck plan there are thirty-three cargo hatches on the spar deck, each one measuring 33 feet by 9 feet in the clear and spaced 12 feet center to center, so that it is possible for the clam-shells to unload the vessel practically without any hand labor.

Fig. 10 shows the latest departure made in the ore-boat construction. In the case of the *Wolvin* the sides of the hold sloped in at an angle, with the idea that the material would run down and be in a better position to be handled by the grab buckets. As is apparent, the sides projected out so as to allow the bucket, when lowering, to drop onto the sides, and much damage can be done to the boats, and there is no real advantage in gathering up the material. In the type of construction shown in Fig. 10, the sides are brought in on a slight slope, and then vertically down to the tank top, the vertical side being inside of the hatch combing, so that a bucket in dropping through the hatch would not come into contact with them, and, furthermore, having the vertical sides, the buckets were able to work close up to them and obtain, with less damage to boat, a bucket of ore, than in the type of boat such as the *Wolvin*. The *Wolvin* type, however, has not been generally repeated, and most of the modern boats have an interior construction very similar to that shown in Fig. 10.

EVAPORATING PLANTS ON BOARD SHIP.

BY WILLIAM J. AUKEN.

Fresh water made by the evaporation of salt water at the expense of coal burned can never be as economical as obtaining the product from shore; hence we find tanks fitted aboard ships, usually of sufficient capacity to furnish all the water needed in runs between ports, where a fresh supply becomes available. There are many exceptions to this rule, however, which may make an evaporating plant desirable, or even a necessity. Naval vessels, with their large crews, making long voyages, together with numbers of ocean yachts, may be considered as in the latter class, while many other ships at some time during their trips, find it extremely profitable to replenish a vanishing water supply outside their port limits.

The usual adjunct for increasing the supply of fresh water beyond the tank capacity is the evaporator. This useful appliance consists of a cylindrical shell containing a cast head on one end, if of the horizontal type, or on the lower side when vertical; to which is attached banks of tubes, and through which steam is passed in order, from the top to the bottom; draining from the last coil into a trap, and thence to the feed tank or hot well. Sea water is fed into the shell surrounding the heated tubes, and being vaporized passes out at the top into the vapor pipe. On many ships this pipe is connected to the auxiliary or main exhaust, the vapor finding its way into the condenser, where it is condensed with the ex-

haust steam and adds to the volume of the feed water. There being a partial vacuum in the exhaust piping, the boiling point of the water in the evaporator is lowered, consequently a greater quantity of water can be evaporated for a given amount of steam than when evaporating under greater pressure.

One or two minor refinements are possible with this method. The low pressure in the evaporator makes a salt feed obtainable without a special pump. Where arrangements permit, this should be taken from the overboard discharge of the main circulating pump, as this sea water has been warmed in condensing the exhaust steam. Locations not permitting, the flushing-line discharge offers another possible suction, though here the water enters at a lower temperature (that of the sea). When a separate evaporator feed pump is advisable, the former suction should be chosen.

This evaporating plant, simple in the extreme, will make large quantities of feed water with little or no attention; takes up but small space, and needs few connections. The objection, which leads to more complicated arrangements, is the quality of water produced. Where the vapor passes directly into an exhaust pipe its quality cannot be tested, hence when poor water is made it must contaminate all of the previous yield. The boiling point of the water being low, because of the partial vacuum under which it is evaporated, the steam bubbles formed are large, the vapor heavier than when higher pressures are used, and the amount of water held in suspension is also greater, hence the tendency to prime is always present. This is aggravated by the usual method of connections.

To insure against this evil, the vapor pipe should rise vertically from the evaporator 10 or 12 feet before connecting into the exhaust, that gravity may free the vapor of the contained water. Its diameter should also be large, decreasing the velocity of the vapor, which adds another safeguard to the tendency of priming. While the latter conditions may be easily met, the former is usually unattainable, due to the necessity of running the exhaust piping without pockets, and serving the other auxiliaries as well.

If it is desired to make water for drinking purposes, the plant described above becomes unsuitable; an independent cooling agent for the vapor being necessary. It is found in the distiller. This device is but a small surface condenser, and as usually made consists of a cylindrical shell, longer than its diameter, with openings bottom and top for the entrance and exit of the circulating water, respectively. Within are top and bottom heads, into which small vertical tubes are expanded, the circulating water flowing through them, while the vapor comes in contact with their outside surfaces, entering near the top and flowing out the bottom as water. The product is then drained to a small fresh-water tank, tested, and if found satisfactory, drained or pumped to the ship's tanks.

It is good practice to furnish two distillers, each of half capacity for every evaporator installed. This arrangement allows one distiller to be cut out, with a saving of circulating water when the evaporator is not working at its full capacity.

Advantage of connections to the flushing system is taken at times to furnish water for distiller circulating purposes, though another method is to reverse the operation, sending water first through the distillers, and thence to the flushing line by means of the same pump. The necessary vertical rise of the vapor pipe, as previously explained, is obtained by placing the distillers in a trunk way or fastening upon a bulkhead. Evaporating under pressure is resorted to when using distillers; a vacuum being neither available nor desirable. The diameter of the vapor pipe may also be reduced over that required for the plant first described.

The essentials for making pure distilled water have now been complied with, but a few modifications will be considered, which tend to a more efficient installation. The evaporator feed should be taken from the distiller circulating pump discharge, that a portion of the waste heat may be utilized. A vapor separator is a recent innovation, and if of efficient design adds materially to the output of the apparatus. It is located in the vapor pipe, between the evaporators and the distillers, preferably near the latter. The usual types of this article which are commonly in use on steam lines are not as successful on vapor pipes. In construction their diameter should be large, as compared with the vapor pipe, that the decrease in velocity may tend to precipitate the moisture from the vapor.

The entrance of the vapor is through the top, the outlet being placed on the side, also near the top, in order to reverse the direction of flow. Two or three sheets of wire gauze placed horizontally across the separator serve to catch the contained moisture at the point where the motion is practically nil. The usual gage glass and fittings, together with a drain, are provided, the latter leading to the bilge or overboard generally through a trap.

An unobstructed drain is essential to the efficient working of this apparatus. Traps when used should be regulated to discharge freely. The writer has obtained excellent results without them by discharging directly overboard; the drain valve being cracked, allowing a small portion of vapor to be continually flowing through the line.

Having passed through the separator, the vapor is lead to a "feed-water heater." The usual cylindrical shell, through which coils of pipe are inserted, is common to most of these, as other heaters. The vapor entering at the top flows around the pipes and out at the bottom; the feed being forced up through the coil in its path to the evaporator. Distillers complete the condensation of the vapor at this point, taking the vapor from the heater by gravity and discharging it to the fresh-water tank previously mentioned.

Water thus made, being devoid of air, possesses that peculiar "flat" taste so nauseating to those unaccustomed to it. This objection is readily overcome by causing an air current to mingle with the newly made water supply. The method of connecting a pipe to the distiller near the bottom is an efficient manner of accomplishing this result; a partial vacuum being produced at this point, due to the condensation of the vapor above it, insuring a constant air supply. The pipe is, of course, led to a suitable height, a return bend upon the upper end serving to prevent the entrance of foreign matter.

Testing water for its purity is done by dissolving crystals of nitrate of silver in the water, weakening the solution until one or two drops of same in a glass of fresh water will not color it. If the sample to be tested does not change to a chalky white when the solution is added, its quality is assured, but the water should not be used when discoloration takes place on the entrance of the testing solution. All samples of water taken will discolor in time if left to stand; the length of time depending upon the strength of the mixture. It needs but little practice, however, to differentiate between good and bad water. As water treated with this solution is more or less poisonous, the sample should be disposed of and not left standing or thrown into the fresh-water tank.

Pipes for carrying fresh water are commonly made of wrought iron, galvanized, rather than brass or copper, to avoid the injurious effects attributed to these metals. If the latter are used they should be tinned.

Engineers differ widely as to the proper method of operating these plants; the fact that water when needed is needed badly leads many of them to increase the output to the greatest extent. The pressure which can be carried in the evaporator coils depends, of course, upon their diameter and

thickness, as an increase of thickness leads to a slower transmission of heat, the economical limit is soon reached. In many evaporators a safety valve limits the coil pressure to 10 pounds, although the writer has raised it to 60 pounds (the test pressure of that particular coil), with a corresponding shell pressure of 10 pounds, and at these pressures almost doubled its rated capacity, furnishing thoroughly good water.

As previously explained, the vapor is drier at the higher pressures, hence the quality of the water should be easier to maintain. That the pressure is not conducive to the greatest economy of steam is, of course, plain. The proper pressure to be carried must be varied to suit the individual conditions of the plant, together with the supply needed. For economical working it may be stated that the pressure in the coils should not be greater than is necessary to produce good water. Where a vapor separator is used, this pressure may be safely lower than when otherwise.

Carry the feed water in the evaporators at a constant height and so that the top row or two of tubes is left bare; this insures drier vapor, which is a material aid to good water. When a vessel is pitching or rolling in a heavy sea, the water level may be profitably lowered even beyond this point.

A dry pipe or its equivalent should always be fitted in an evaporator, and baffle plates, especially in the horizontal types, are an aid, sometimes a necessity.

The speed of the distiller circulating pump should be such that the vapor is thoroughly condensed. If an outlet is left in the connections where the vapor, if present, will escape in view of the operator, the speed of the pump may be regulated accordingly. The common method of placing a reducing valve in the steam supply to the plant is an excellent one, making the operation almost automatic, after a preliminary regulation.

The shell pressure of the evaporator will adjust itself to the steam supply, the final indication of which depends upon the heating surfaces of the coils and their conditions as regards the amount of scale upon their surfaces. In properly designed plants this pressure should be allowed to come what it may. Throttling the vapor discharge may be resorted to, however, if an increase in the shell load is still within its safe working limits, and a higher pressure is conducive to better water.

The use of an evaporator is coincident to the deposit of salt scale, which can be reduced to a minimum, by the judicious use of the blow connection; the increase in density of the water is also not conducive to rapid evaporation. A salinometer and pot, familiar to the engineer in his tests of boiler feed water, will also determine the proper time to "blow" the evaporator. The density may be carried somewhat higher, however, 4/32 to 5/32 being not uncommon. Other engineers "blow" at stated periods, without regard to the salinometer readings.

Compounding with evaporators has been suggested for marine installations, but has not met with favor. In this process, the vapor from the high-pressure evaporator is made to take the place of the steam in the low pressure one by passing it through the coils, draining to a trap as before, and thence to the fresh-water tank in the evaporator room. Provision must be made for running each unit independent with this system, as required when scaling or overhauling one of them, adding to the multiplication of fittings. This, together with the added weight, due to the greater pressure carried in the high-pressure evaporator, is considered to more than offset the gain in economy.

It has been suggested by Lieutenant-Commander Delaney, U. S. N., that the vapor from the evaporators should be run to the main feed-water heaters and used to heat the water entering the boilers. Where the output of the plant is constant and of sufficient volume, such a scheme might be worked out to advantage, the exhaust steam now used for this purpose being displaced to the condenser direct.

THE MARINE STEAM ENGINE INDICATOR—VIII.*

BY LIEUT. CHARLES S. ROOT, U. S. R. C. S.

REDUCING MOTIONS (CONTINUED).

The principle of the inclined plane is frequently utilized for reducing motions, more especially on long-stroke paddle engines running at slow rotative speeds. Certain forms are also applicable to short-stroke auxiliaries, and recently the inclined plane, in the form of a long pitch screw, has been used on engines of moderate stroke, with speeds as high as 120 revolutions per minute.

A reducing motion of the first kind designed by Messrs. J. F. Metten and Sven P. Meurk and fitted to the inclined paddle engines of the steamship *Commonwealth* is shown in Figs. 53 to 57. Fig. 53 is a plan, and Fig. 54 a longitudinal elevation of

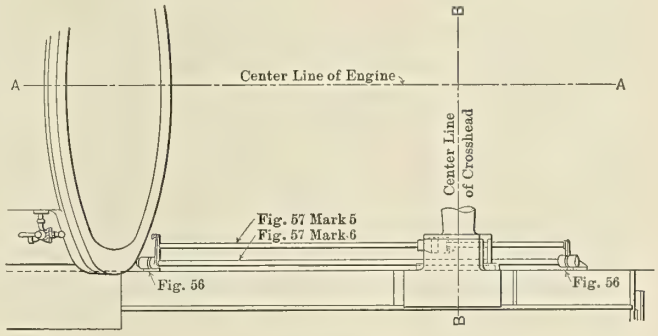


FIG. 53.

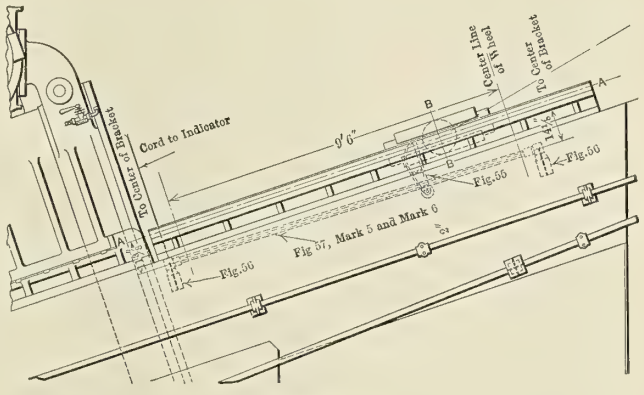


FIG. 54.

a part of the engine frame. The crank end of one of the main cylinders is seen at the left. *AA* is the center line of the piston rod, and *BB* the center line of crosshead journal. Brackets are bolted to the housing as shown. These bearings carry the shaft (mark 6) illustrated in Fig. 57. The bracket drawn in detail in Fig. 55 is bolted to the engine crosshead. This bracket carries at its lower end a 4½-inch flat-faced composition pulley. The outer bar of the rocker frame, Fig. 57 (mark 5), rests on this pulley. It will be noticed on reading the dimensions indicating the location of the center line of the rocker frame on the longitudinal elevation, that this frame is inclined relative to the center line of the piston or crosshead travel. When the engine is in motion, the inclination causes the outer bar of the rocker frame to describe the arc

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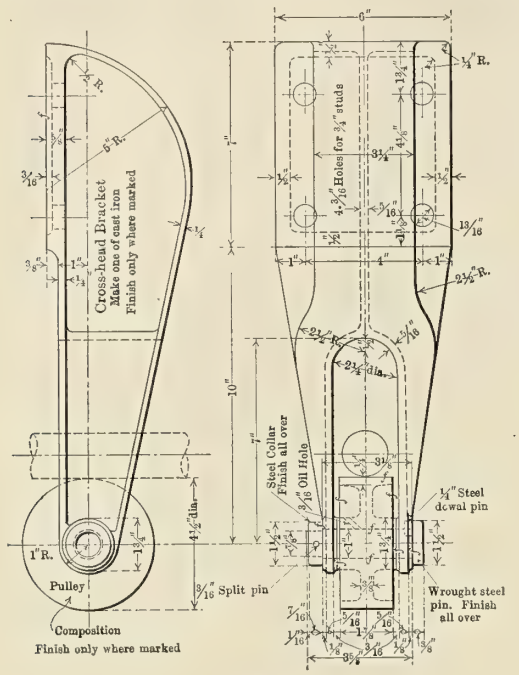


FIG. 55.

of a circle, and the pin, Fig. 57 (mark 9), on the cylinder end of the frame, of course, has a similar motion with a larger radius. The indicator end is attached to the pin and transmits the movement to the paper drum. The weight of the frame keeps it in contact with the pulley on the crosshead bracket and takes up all back lash. This mechanism is not absolutely

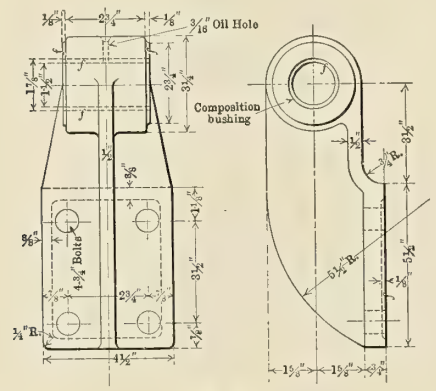


FIG. 56.

correct, owing to the necessary angularity of the cord when in certain positions, but as the cord length on this particular gear is about ten times the radius of the arm, the error is almost, if not quite, negligible. This gear is, of course, only suitable for very slow rotative speeds.

On smaller engines turning at higher speeds the device shown in Fig. 58 is sometimes found. The swing of the bell crank *B* is adjusted to the indicator by altering the inclination of the slide *A*. This mechanism also lacks precision, due to cord angularity. If *A* and *B* are not connected by a pin and slot, a recoil spring should be fitted to assist the indicator drum spring in keeping the parts in contact.

The principal part of the screw-gear reducing motion mentioned at the beginning of this section consists of a bar or shaft very similar to the bar attached to the tool head of a gun-rifling machine. This shaft is mounted in suitable bearings, with its center line parallel to the line of stroke and close

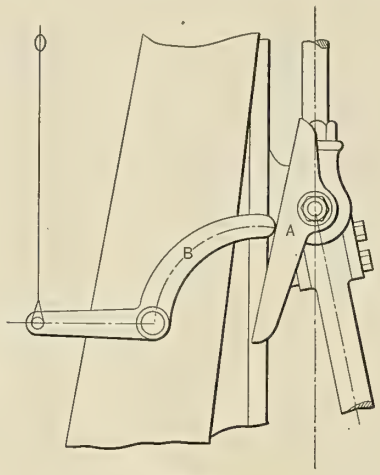


FIG. 58.

to the crosshead. Thrust blocks are fitted at one or both ends. A spiral groove of uniform twist is planed in this shaft with a pitch of, say, thirty times the diameter of the shaft. A bronze nut or sleeve slides on the shaft. This sleeve is so fastened to the crosshead that it cannot revolve and is provided with a feather or helical key, which slides in the groove in the shaft. The crosshead in its forward and backward motions causes the shaft to rotate first in one direction and then in the other. A suitable wheel or drum on the end of the shaft transmits its motion through a cord to the indicator in the usual manner. This mechanism gives a correct reduction. This shaft is somewhat difficult to machine, but if the reader will consult any good work on gunnery he will find there an interesting description of the methods used in making rifling bars, and these will apply to a job of this kind.

Another series of movements which are very handy for temporary use on slow-moving machines may be rigged with pulleys and cords. Suppose that it is desired to indicate a pump having a stroke of 8 inches. Take a single pulley and connect it as shown in Fig. 59. The pull of the indicator drum spring is supported by two cords, and the velocity ratio is 2 to 1. That is, if the pump has a stroke of 8 inches, the single cord leading to the drum will move 4 inches. If the stroke of the machine is 11 inches, a "gun tackle" can be mounted as in Fig. 60. The tension of the drum spring is here supported

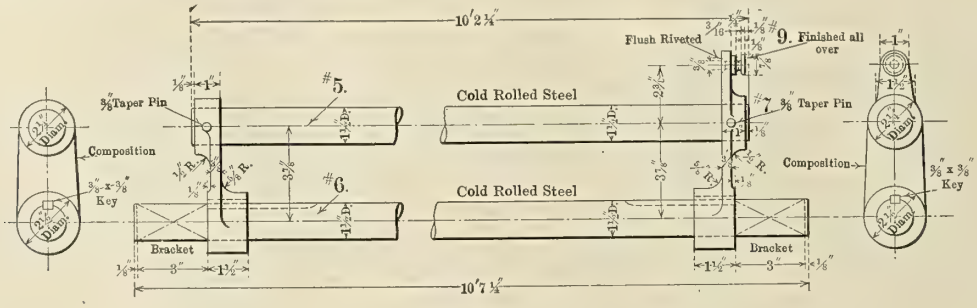


FIG. 57.

by three parts of the cord, the velocity ratio is 3 to 1, and with a stroke of 11 inches the cord will have a travel of 3 2/3 inches. The different velocity ratios possible with pulleys are almost infinite, and the reader will find no difficulty in devising a combination to suit his purpose. Care should be taken to have the pulleys as light in weight and as free from friction as possible, and where more than one set of sheaves

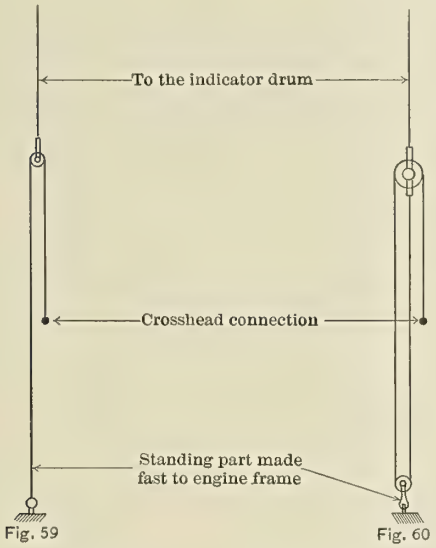


Fig. 59 Fig. 60

is used they should be of such diameter that the cords may all be parallel. Pulleys of different diameters are shown in Fig. 60. These motions will all be accurate if the cords are parallel with each other and with the line of stroke of the engine.

The lever mechanism in its various forms, which is without doubt the reducing motion *par excellence* for vertical propelling engines, will be considered next.

(*To be Continued.*)

STEAMSHIPS BEAR AND BEAVER.

Two steel passenger and freight steamships have just been completed by the Newport News Shipbuilding & Dry Dock Company, Newport News, Va., for the San Francisco & Portland Steamship Company. These ships have been named the *Bear* and *Beaver,* and are both of the following dimensions:

Length over all, about	380 feet
Length, after-side of stem to fore-side of rudder post	364 feet
Beam, molded	47 feet
Depth, molded, to hurricane deck	34 feet
Depth, molded, to main deck	26 feet
Load draft	19 feet 6 inches
Tonnage, gross	4,100
Speed, loaded	15 knots

The vessels are steel hull, single screw, passenger and freight steamships of the hurricane-deck type, with a straight stem and semi-elliptical stern, and are schooner rigged, with two steel pole masts. There are complete lower, main and hurricane decks, and two tiers of deck houses above the hurricane deck. There is also an orlop deck in Nos. 1 and 2 holds, a promenade deck over the houses on the hurricane deck, and a flying bridge at the level of the top of the promenade deck house. A complete double bottom is fitted, and the vessel is subdivided into compartments by five watertight bulkheads.

Accommodations for 276 first class passengers are provided in ninety-two staterooms of three berths each, located on the main deck aft of the machinery, and in houses on the hurricane and promenade decks. The staterooms on the main deck are arranged generally in sections of four rooms each, with alcoves between the sections; all staterooms in the deck houses are outside rooms.

The main dining-room, with a seating capacity for 162 people, is located on the main deck aft of the engine casing, and the main stairway connecting the dining-room and a social hall above is located on the after side of No. 3 hatch.

SINGLE-SCREW PASSENGER AND FREIGHT STEAMSHIP BEAR.

A large smoking room is fitted on the promenade deck.

Accommodations for second class passengers are provided on the lower deck forward, with berths for eighty-seven men and eighteen women.

The propelling machinery consists of six return-tube Scotch boilers, one vertical donkey boiler, triple-expansion engines with cylinders 31, 50 and 84 inches diameter by 54-inch stroke, and one surface condenser independent of the engine framing.

The main valves for the high-pressure and medium-pressure cylinders are of the piston type, and the valves for the low-pressure cylinder are of the flat type. The valve gear is of the Stephenson link-motion type, with double-bar links.

The six main boilers are each 13 feet 6 inches diameter by 11 feet 6 inches long, with three corrugated furnaces and separate combustion chambers. The working steam pressure is 190 pounds per square inch. The boilers are fitted for burning oil fuel, with steam atomization.

The vertical donkey boiler is 6 feet 6 inches diameter by 11 feet high, built for 190 pounds steam pressure and arranged to burn either coal or oil.

The vessels have combined steam and hand-steering gear, with a steering engine of the Sickles type located on the main

ARRANGEMENT OF LIFE BOATS WITH WELIN QUADRANT DAVITS ON THE PROMENADE DECK.

deck forward. Auxiliary steering gear of the right and left-hand screw type is directly attached to the rudder stock.

There is a steam windlass with attached capstan forward, the windlass being located on the main deck, and the capstan on the hurricane deck. There is also a steam capstan on the hurricane deck aft.

An electric plant consisting of one 15-kilowatt and one 25-kilowatt generating set is located in the lower engine room, and there is an 18-inch searchlight on the navigating bridge.

Welin patent boat davits are provided for handling the life boats, the latter all being located on the promenade deck. This installation, as shown by the illustration, presents a neat, yet substantial and business-like appearance, taking up a minimum amount of space. Double stands have been used between the boats in order to save deck space.

The *Bear* was launched on Oct. 16, 1909, and the *Beaver*, Nov. 27, 1909.

The trial trip of the *Bear* was run on Jan. 10, off the Virginia Capes, during which a speed of 16 knots was attained, the engines indicating 4,500 horsepower at 86 revolutions. Oil fuel was used on the trial.

The *Bear* left the latter part of January for the Pacific Coast, with a cargo of steel and other freight; and the *Beaver* was completed early in February. The contract time for building the *Bear* was seven months, and she was delivered four days ahead of this time, thus netting her builders a bonus, besides upholding their well-earned reputation for prompt and speedy work.

BOILER ATTACHMENTS AND FUNNEL DRAFT.

BY LIEUT. H. K. SPENCER, U. S. R. C. S.

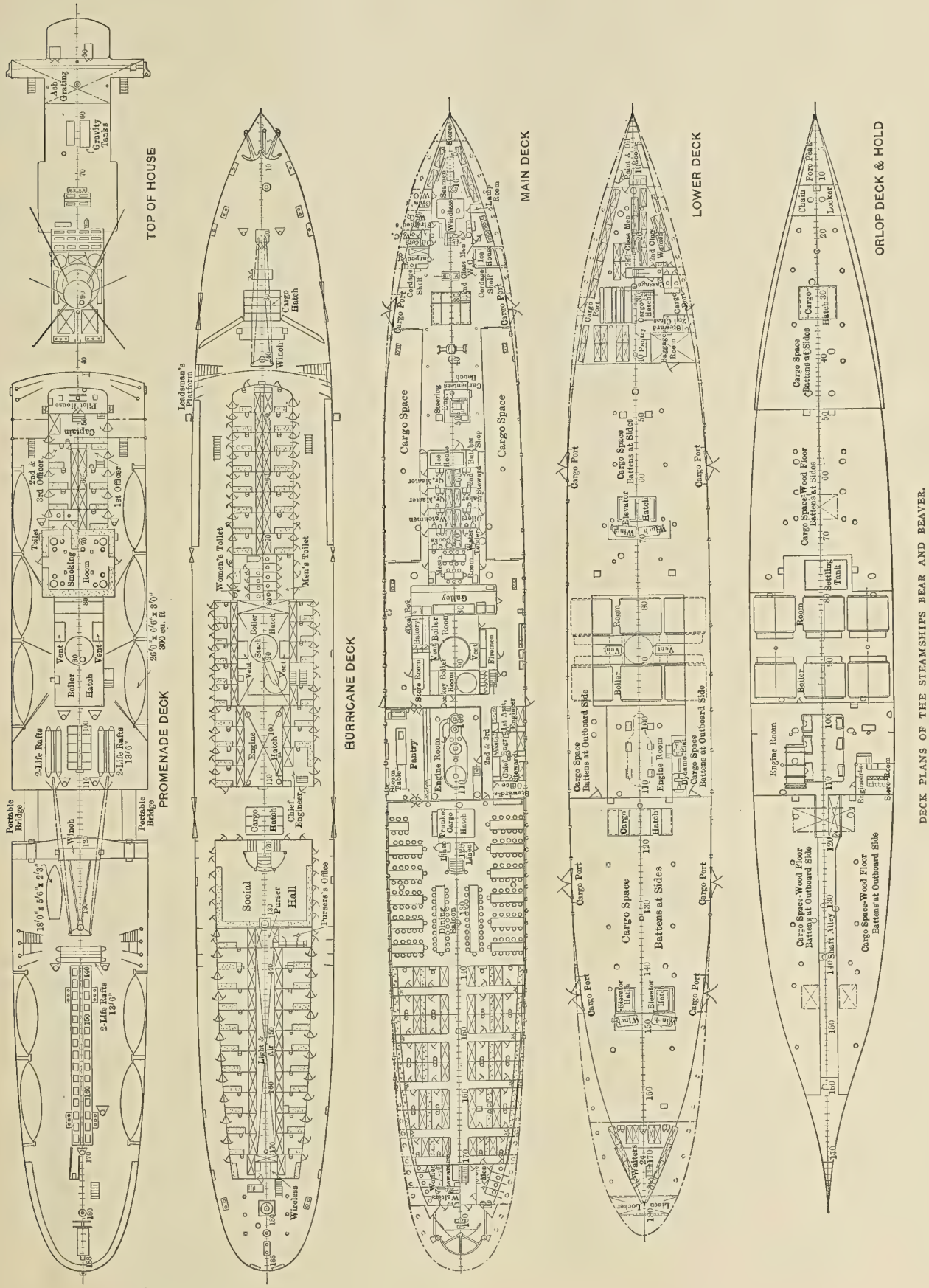
Assuming that the proper grate area and heating surface have been assigned to boilers designed to furnish a required amount of steam at a certain pressure; that the thickness of the shell plates has been determined, the riveting designed for the different styles of joints to be used in putting the boiler together, the bracing arranged and its strength calculated, the next consideration will naturally be the attachments necessary to the operation of the boilers.

A steam dome, or drum, is no longer considered necessary in order to get dry steam from a boiler. That attachment is done away with by providing a dry pipe leading from the stop valve opening lengthwise, inside the boiler, and as high as possible. Its sectional area must be at least as great as the area of the stop valve opening, and through the upper side slits are cut, or holes drilled, having an aggregate area of at least the cross-section of the pipe, and they are sometimes given an aggregate area of as much as one and one-half times that. The free end of the pipe is closed.

While there are several methods and many rules for determining the size of the safety valve, any one of which may give a valve of sufficient size to relieve a given boiler of all the steam it will make when fired to its full capacity, it must, as a minimum, be of a size determined by the rules of the United States Steamboat Inspection Service. That law provides that, if loaded with a weight acting directly, or through a lever, the safety valve must be given ½ square inch of area for each square foot of grate surface in the boiler, and if spring loaded, 1/3 of a square inch of area for each square foot of grate surface. If the diameter of the single valve obtained by the above rule is greater than 5 inches, two valves must be used, each having an effective area of at least one-half that of the single valve. Means, independent of the steam pressure, must be provided for raising each valve from its seat to a height equal to one-eighth the diameter of the valve opening.

The main stop valve and steam pipe should be given such size that the velocity of the flow of steam through them will not exceed 6,000 feet per minute. When there are two or more boilers, the aggregate area of their stop-valve openings should exceed the area of the main stop valve opening by about 25 percent, as should also the aggregate sectional area of the pipes connecting the different boilers to the main steam pipe. All bends should be made as long and easy as possible, and pockets, where water might accumulate, must be avoided. The inevitable expansion and contraction of the piping under change of temperature must be taken care of. Very often the bends in the branch pipes from the different boilers are considered sufficient to safely take the expansion there, but with the main steam pipe it is very seldom that the bends can safely be relied upon for that duty, and an expansion joint of some kind must be provided. When an expansion joint is used, the sections each side of the joint should be securely anchored to the deck from their further ends; that is, in such a manner that none of the thrust of expansion comes on the fittings at the ends of the section of piping in which the expansion joint is placed.

For boiler stop valves, the writer's preference would be heavy, angle, or globe valves, closing toward the boiler, and so designed that the stems can be packed when the valves are wide open. The way valves should be of a similar design,



DECK PLANS OF THE STEAMSHIPS BEAR AND BEAVER.

then all can be packed, whether the boilers are under steam or not.

The connections for the water columns should be ample, not less than ½ inch. Cocks, instead of valves, should be used, and placed on the boiler at each end of the pipe, and provision made for keeping the connections clear, both by blowing out and mechanically. A number of excellent devices are on the market for automatically closing the water and steam-gage glass connections when the glass breaks. The use of these devices eliminates some danger and considerable annoyance.

The surface blow should be larger than the bottom blow, and of a size sufficient to create a current toward the scum pan, when the blow-off valve is opened. The sea valve, to which this pipe connects, should be of the same size. A branch should be taken from the bottom blow pipe to the donkey pump, to be used as a suction for pumping out the boiler, so that it can be allowed to cool before emptying for cleaning. Another branch, giving the injector suction through the bottom blow should be arranged, so that the injector can be used for circulating and heating the water in the boilers before lighting fires. A drain cock should be fitted to the bottom of every boiler.

The main feed pipes should be of such diameter that the velocity of flow through them does not exceed 300 feet per minute, and for small pipes, 2 inches and under, the figure should be 200 feet per minute and less. The feed checks are best of large diameter and small lift. A stop valve should be placed between the check and the boiler. The feed water should be led by an internal feed pipe, always below the water level, to a part of the boiler where there is a decending current, or to the bottom of the boiler.

Even when mechanical draft is used, the smokestack, or funnel, should be proportioned to enable the boilers to steam at very nearly their full capacity, in case of failure or accident to the artificial draft apparatus. The smokestack is the only means of creating a draft that does not require additional apparatus and attention.

The amount of oxygen required to effect the combustion of 1 pound of carbon is 2 2/3 pounds, or 12 pounds of air. It is found in practice, however, that more than that is required to effect complete combustion, and that the quantity depends upon the nature of the draft. With artificial draft about 18 pounds of air are required per pound of coal, and with natural draft about 24 pounds. The weight of the products of combustion, with natural draft, then is, $24 + 1 = 25$ pounds per pound of coal burned on the grates, and the volume of the mixed air and products of combustion may be considered the same as that of the air supplied the furnace when at the same temperature. One pound of air, at 32 degrees F., has a volume of 12½ cubic feet, and 24 pounds, the amount necessary to consume 1 pound of coal completely, would have a volume of 300 cubic feet. At any other temperature than 32 degrees F., the volume will equal that at 32 degrees multiplied by the ratio of the absolute temperature of the new temperature to the absolute temperature of 32 degrees F., so at a temperature of, say, 500 degrees F., the volume would be $300 \times (500 + 461) \div (32 + 461) = 585$ cubic feet.

The difference in the weight of a column of outside air of the same height as the funnel above the lowest fire bars, with a cross-section equal to that of the funnel and the column of hot gases within the funnel is the measure of the force that produces the draft. Let T_{32} be the absolute temperature at 32 degrees F., T_1 the absolute temperature of the air outside the funnel, T_2 the absolute temperature of the gases inside the funnel, V_{32} the volume at 32 degrees F. of air supplied per pound of fuel burned on the grates, and H the height of the funnel in feet above the lowest grates. A cubic foot of air at 32 degrees F. weighs $1 \div 12\frac{1}{2} = .08$ pound, therefore $.08\ (T_{32} \div T_1)\ H$ equals the weight of a column of air outside the funnel of a height equal to that of the funnel, and with a cross-section of 1 square foot. The weight of a corresponding column within the funnel is

$$\left(.08 + \frac{1}{V_{32}}\right) \frac{T_{32}}{T_2} \times H = \left(.08 + \frac{1}{300}\right) \frac{T_{32}}{T_2} \times H = .0833 \frac{T_{32}}{T_2} H$$

The force of the draft, that is, the difference of pressure within and without the funnel, is measured with a water syphon gage, which is simply a glass "U" tube, used with one end open to the air, and the other connected to the funnel. In use, it is filled about half full of water, which, when the connection to the funnel is opened, shows at different levels in the two legs of the "U" tube, and so indicates the difference of pressure within and without the flue. The difference in level in the two legs, measured in inches, and expressed as "inches of water," is the common measure of the intensity of draft. A column of water 1 inch high gives a pressure of 5.203 pounds per square foot, so, if the draft pressure per square foot be multiplied by $1 \div 5.203 = .1923$, it will give the intensity of draft expressed in inches of water; that is, the intensity of draft $= h = .1923\ (.08 \times T_{32} \div T_1 - .0833 \times T_{32} \div T_2)\ H$. The draft intensity in practice varies from .3 to .6 inch of water, according to the rate of combustion and the size of the steamer, and is sufficient to burn any of the coals ordinarily used for steam-making.

T_{32} is a constant, $= 32° + 461° = 493°$ absolute temperature, so the last equation can be rewritten $H = h \div (7.585 \div T_1 - 7.897 \div T_2)$. Assume the conditions, $T_1 = 521°$, $T_2 = 861°$, which are, respectively, the absolute temperatures corresponding to 60 degrees F. and 400 degrees F., and that a draft of .4 inch of water is required, then $H = .40 \div (7.585 \div 521 - 7.897 \div 861) = 74.21$ feet, which is the height that must be given a funnel to produce a draft of .40 inch.

Considering the cross-section of the funnel, it is evident that it should not be less than the total cross-section of all the tubes of all the boilers connected to it, as a contraction of the stream of hot gases, after leaving the tubes, could not be otherwise than detrimental to the draft.

It is generally stated that the power of a chimney to produce draft varies as the square root of the height, or, as one writer states it: (Holmes—*The Steam Engine*) "Then, since 1 cubic foot of air at 32 degrees F., or T_{32}, weighs $1 \div 12\frac{1}{2} = .08$ pound, therefore $H\ (.08 \times T_{32} \div T_1)$ is the weight in pounds of a column of outside air of the height of the chimney standing on an area of 1 square foot. The corresponding volume within the chimney weighs $H\ (.08 + 1/V_{32})\ T_{32} \div T_2$ pounds, and the difference between these two weights is the pressure in pounds per square foot of chimney section which produces the draft. A column of hot gas equal in weight to this difference is called the head of the chimney, and, just as in hydraulics, the velocity of discharge of water from a full vertical pipe is proportional to the square root of the height of the pipe, so in the case of a chimney, the velocity with which the air would flow, if unimpeded, into the bottom of the chimney, is also proportional to the square root of the height of the head. The height of the head, reckoned in feet of hot gas, is found by dividing the weight of a column of external air as high as the chimney, as found above, by the weight of 1 cubic foot of the hot gas. (This gives the height of a column of hot gas weighing as much as the column of external air.) If we subtract from this the height of the chimney, the difference is the height of the head."

The motion of the hot gases up the funnel may or may not

be accelerated; however, it is reasonable to conclude that the retardation, due to gravity, loss of temperature and friction inside the funnel of the upward moving volume of heated gas, is compensated by the constant pressure or positive accelerating force maintained in the ash-pit, and that, therefore, the motion is uniform. The total pressure maintained in the ash-pit to force the air through the grates and the mass of fuel upon them, is the difference in weight of two volumes of gas equal to the volume of the funnel; that outside the funnel at an absolute temperature T_1, and that inside the funnel at an absolute temperature T_2. The draft may then be said to be of a certain pressure per square foot of grate area, so, if the two volumes of gas under consideration do not change; that is, if the volume of the funnel is kept constant, the total pressure to produce draft is not changed, and the draft pressure per square foot will, with equal grate areas, also remain unchanged, and consequently the rate of combustion will remain the same. Hence, it follows that the height of a funnel may be decreased and its cross area increased without changing the draft pressure per square foot of grate surface, so long as the volume is kept constant. As it would be detrimental to the draft to make the sectional area of the funnel less than the sectional area of all the tubes of all the boilers connected to it, the unit in designing a funnel may then be taken to be that one having a cross-section and height sufficient to give the desired force of draft, then, if it is desired to use a shorter stack and not change the force of draft and the rate of combustion, the height may be reduced to a minimum, keeping the volume constant.

There seems to be some advantage gained in making the sectional area of the funnel greater than the cross area of all the tubes of all the boilers connected to it, and, at the same time, so reducing the height as to maintain the condition of constant volume. The maximum sectional area that can advantageously be assigned to a funnel would appear to be that equal to the net area for draft through the grates and the mass of fuel upon them. The corresponding height, keeping the volume constant, would then be the minimum.

Suppose that the desired force of draft is .40 inch of water, and that the boilers connected with the funnel have a total grate area of 200 square feet, and that the sectional area of all the tubes of all the boilers is equal to one-sixth of the total grate area, or 33.33 square feet, which is also the sectional area of the stack to be used as a unit, so its diameter will be 6.52 feet. The necessary height of chimney to produce a draft of .40 inch, assuming that the mean temperature of the gases inside the stack is 400 degrees F., was found to be 74.21 feet, so the volume of any chimney to maintain the required draft must never be less than $74.21 \times 33.33 = 2{,}474$ cubic feet. The area of grates is 200 square feet, and the area of the openings between the bars will be about one-half of this, and the area for the passage of air through the mass of fuel on the grates will be about one-half of that, so the greatest sectional area that should be given the stack is $200 \times .5 \times .5 = 50$ square feet, which would make the minimum height $2{,}474 \div 50 = 49.48$ feet; that is, the stack should be given that height above the lowest grates, and a diameter of 7.98 feet.

If it is considered that a higher stack, say 65 feet, would keep the decks more free of cinders and present a better appearance, then it should be given a sectional area of $2{,}474 \div 65 = 38.06$ square feet, and its diameter would be about 7 feet. A draft of .40 inch of water is sufficient to burn ordinary steam coal at the rate of about 18½ pounds per hour per square foot of grate surface, and a stack 65 feet high and 7 feet in diameter is large enough to furnish sufficient draft to burn coal at the rate of 18½ pounds per hour per square foot on the grates of boilers having a total grate area of 200 square feet, an area sufficient for boilers supplying steam to a triple-expansion engine of 2,000 indicated horsepower.

The smokestack as designed has a volume of $2{,}474 \div 200 = 12.37$ cubic feet per square foot of grate of all the boilers connected to it. It has been stated that the unit to be used in designing a smokestack is that one having a sectional area equal to the area for draft through all the tubes of all the boilers connected to it, and a height sufficient to give the desired force of draft. That height having been obtained, the necessary volume of stack has been determined, and the height and diameter can be varied, keeping the volume constant, to suit the conditions of appearance, etc.

In the case considered above, the ratio of the grate surface to the area for draft through the tubes, which area is called the calorimeter of a boiler, was taken to be 6 to 1, but in practice this ratio varies from 5 to 8, so it is seen that boilers having the same grate areas, but different calorimeters, would have different sizes of funnels if the above method was followed exactly. The power of a boiler is principally fixed by its ability to burn coal, so, if the grate is of ample size, and the smokestack of sufficient height and sectional area, the principal remaining factor affecting the boiler's ability to burn coal is the area for draft through the tubes. Ratios of grate surface to calorimeter of 6 and 7 to 1 are very common; better results being obtained with the lower ratio, so it is assumed that, in all cases, the ratio is 6 to 1, then the unit volume of smokestack will be $H \times (G.\ S. \div 6)$ cubic feet, where $G.\ S.$ is the grate area in square feet. The volume of the funnel per square foot of grate will be $H \times (G.\ S. \div 6) \div G.\ S. = H/6$ cubic feet, and the following table is calculated from the equation $H = h \div (7.585 \div T_1 - 7.897 \div T_2)$, assuming that the average temperature of the stack is 400 degrees F., and that the average temperature of the outside air is 60 degrees F. Taking the net area for draft through the grates and the fuel upon them to be $G.\ S. \div 4$, the least allowable height for the stack would then be two-thirds that given in the table:

h = draft in inches of water.	H = height of stack for draft, h.	Volume of stack per sq. ft. of grate.
.30	55.68	9.28
.35	64.96	10.83
.40	74.21	12.37
.45	83.52	13.92
.50	92.80	15.47
.55	102.10	17.02
.60	111.40	18.57
.65	120.70	20.12
.70	129.90	21.65
.80	148.50	24.75
.90	167.00	27.83
1.00	185.60	30.93

The height of stack is given in feet, and the volume per square foot of grate in cubic feet.

The above method will be applied to an actual case, a steamer carrying freight and passengers on the Atlantic Coast. In service, this steamer regularly, and without any approach to forcing, burns, with natural draft, between 16 and 17 pounds of coal per hour per square foot of grate surface, a rate of combusion which should be maintained with a draft pressure of .30 inch of water, so, from the table, the smokestack should be given a volume of 9.28 cubic feet per square foot of grate in the boilers. The boilers have a total grate area of 182 square feet, so the volume of the stack should be $182 \times 9.28 = 1{,}689$ cubic feet. Taking the sectional area to be $G.\ S./6$, gives $182/6 = 30.33$ square feet, or a diameter of 6.22 feet. The height given in the table to produce a draft of .30 inch of water is 55.68 feet. The stack would then be made 56 feet high, with a diameter of 6 feet 3 inches. The actual stack is 52 feet 4 inches high, above the lowest grates, and has a diameter of 6 feet 6 inches, which gives it a volume of 1,697 cubic feet, or 9.54 cubic feet per square foot of grate surface.

As another example, take a large, high-powered vessel with watertube boilers, having a grate surface of 1,460 square feet.

This vessel burns easily, with natural draft (at a pressure of .45 inch of water) 22 pounds of coal per hour per square foot of grate. To create a draft of .45 inch requires a stack 83.52 feet high above the lowest grates, and if given a cross-section equal to *G. S./6*, that will be 1,460/6 = 243.33 square feet. In this case, however, there are four stacks, so each will have a cross-section of 60.83 square feet, and a diameter of 8.80 feet. Each of the stacks would then be made 84 feet high, with a diameter of 8 feet 10 inches. The actual stacks are 90 feet high, with a diameter of 8 feet 6 inches, and a total volume per square foot of grate of 13.99 cubic feet.

Stronger draft is required to burn coals of the poorer qualities, and those that cannot be described as free burning than is necessary to obtain good results with the best grades of bituminous coal. The writer has in mind a vessel which with such coal as Pocahontas, does fairly well, but with coal of a comparatively low grade, her steaming qualities are far from satisfactory, as the draft is not sufficient. Not only it is difficult to maintain steam at anywhere near full power, but the economy is very low, even when steaming at what should be her most economical speed. As originally planned, this vessel was to have been provided with two funnels, but during her construction that was changed and only one fitted. The vessel has two boilers, each with a grate surface of 63 square feet, making a total of 126 square feet. The original plans called for two funnels, each 52 feet high, above the lowest grates, and with a clear inside diameter of 4 feet 6 inches. These dimensions would have provided a funnel volume of 13.13 cubic feet per square foot of grate surface, which, it is seen by referring to the above table, should give a draft pressure of .42 inch of water, a force of draft ample for burning any of the coals ordinarily used for steaming. As built, the vessel was provided with one funnel 52 feet high, above the lowest grates and 4 feet 10 inches in diameter. These dimensions provide 7.74 cubic feet of funnel volume per square foot of grate area, which should create a draft pressure of .25 inch of water. This is not sufficient to get the best results, even from the best grades of bituminous coal. The ratio of stack volume to grate area should never be such that the resulting draft pressure is below .30 inch of water, even when the best free-burning bituminous coal is to be used, and for the average coals a proportion that will produce a draft pressure of about .40 inch of water should be given to insure good results.

Considerations affecting the rate of combustion are the length of grates and the sectional area for draft below the grate bars. With short grates the fires can be worked better and with less labor, and the grates can easily be kept uniformly covered with fuel. With long grates, 6 feet and over, the fire is liable to burn into holes at the back end and permit an inrush of cold air, which deprives the other parts of the fire of their proportion of air and reduces the efficiency of the furnace. With short bars, the higher efficiency of furnace obtained is due, to a great extent, to the greater supply of air per square foot of grate admitted below the bars; that is, with a given diameter of furnace, the area at the mouth of the ash-pit is the same, whatever the length of the bars may be. It is sometimes stated that "the consumption of coal is very nearly proportional to the diameter of furnace," a statement that practice seems to verify.

A New Engineering Laboratory at Yale University

Dr. Russell H. Chittenden, director of the Sheffield Scientific School of Yale University, has announced a gift to the school of $250,000 (£51,400) for the construction and equipment of a new mechanical engineering laboratory. The gift is from two graduates of the school of the class of 1888, Mr. George G. Mason, of New York city, and his brother, Mr. William S. Mason, of Evanston, Ill.

THE PRINSES JULIANA.

The twin-screw steamer *Prinses Juliana* was constructed at the Govan shipyard of the Fairfield Shipbuilding & Engineering Co., Ltd. She is the first of three vessels which the Zeeland Steamship Company of Flushing have ordered, and she will shortly take up the night service between Queensborough and Flushing. Her principal dimensions are as follows:

Length over all	363 feet
Breadth molded	42 feet 6 inches
Depth to upper deck	25 feet
Draft	12 feet
Indicated horsepower	8,000
Speed at sea	21 knots
Tonnage, gross	3,000

The propelling machinery consists of two direct-acting, triple-expansion, surface-condensing engines, each having four inverted cylinders, with cranks on the Yarrow-Schlick-Tweedy system of balancing. One of the low-pressure cylinders is at the forward end, and next to it is the high-pressure. Then comes the intermediate-pressure cylinder, with the second low-pressure at the after end. The cylinders are 28, 43½, 49, 49 inches in diameter, with a common stroke of 33 inches, and are designed to develop about 8,000 indicated horsepower when driving the ship at 21 knots sea speed.

The valves of the high-pressure and intermediate-pressure cylinders are of the piston type, the others are flat, and all are operated by the Stephenson double-link motion. Each engine has one condenser of steel plate with cast iron ends. The tubes are of solid drawn brass, and the tube plates of solid rolled brass. There are two circulating pumps of the centrifugal type, and two air pumps of Weir's independent monotype. There are two feed pumps of Weir's make, which draw from the feed heaters and discharge into the boilers. The two propellers have each three blades of manganese bronze, with bosses of cast steel, having zinc protectors to prevent corrosion.

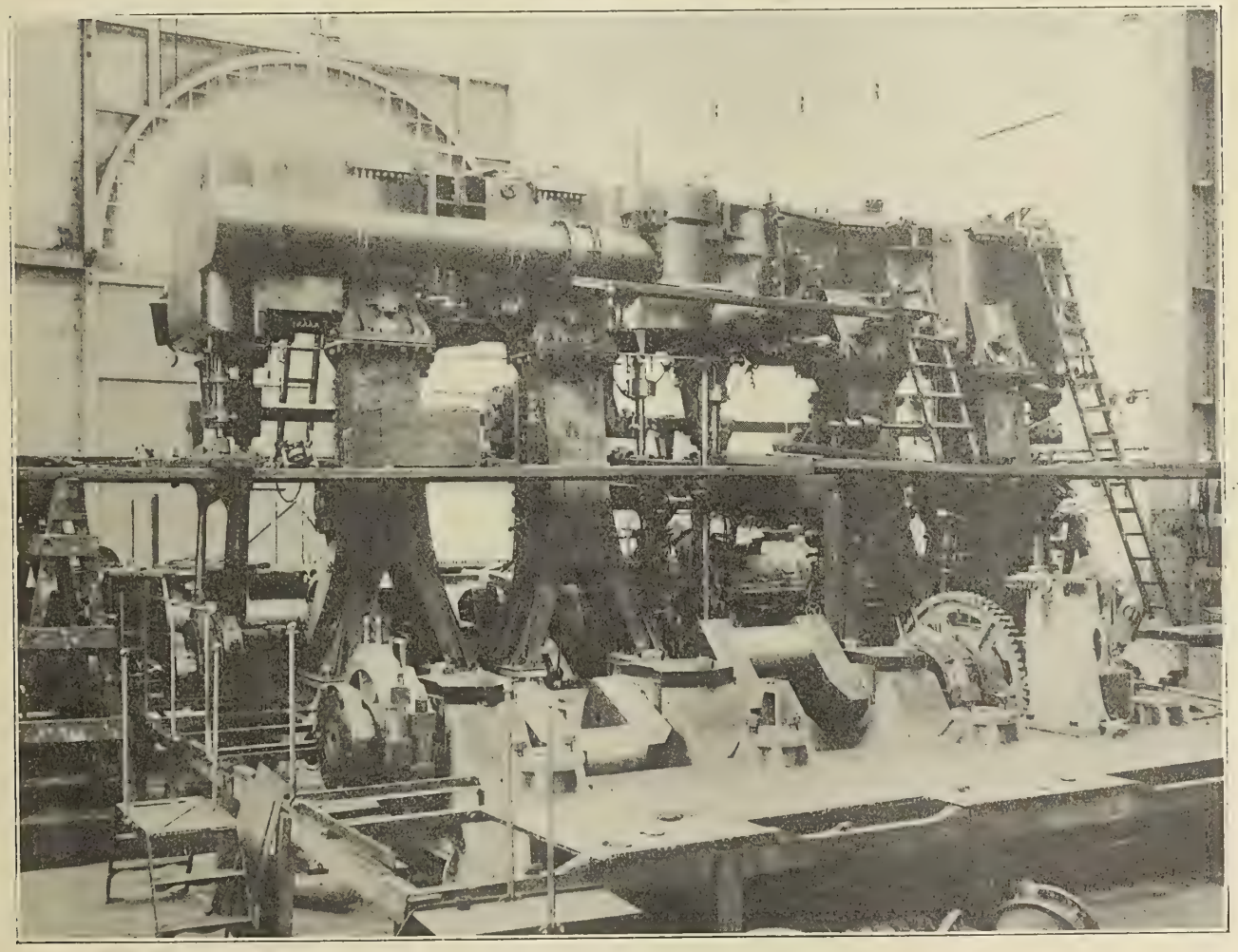
The steam generating plant consists of four double-ended boilers of the multitubular type, each designed for a working pressure of 180 pounds per square inch. They are each 15 feet 6 inches diameter and 18 feet long and are placed in two boiler rooms. All the furnaces are of the suspension bulb type, working under Howden's system of forced draft; air being supplied by four electric-driven fans.

Two See's ash ejectors are fitted for the quick disposal of ashes.

The electric generating plant consists of two sets, manufactured by Messrs. Allen, of Bedford. Each set is constructed for a continuous output of 75 kilowatts at 100 volts when running at a speed of 500 revolutions per minute.

The ship is built to Lloyd's A class for channel service, and has five decks, named in the following order: Lower, main, upper, promenade and boat deck. She is fitted with two funnels and two pole masts, and has been specially designed for the night service between Queensborough and Flushing. Provision has been made to accommodate a large number of passengers, and a special feature is the one-berth cabins, of which there are many. Passengers may enter the main stairway either on the promenade or the upper deck, according to the height of the tide at the landing stage. From the first class entrance hall the passenger goes down a broad and easy stairway to the first class dining saloon on the main deck and to the first class staterooms. The dining saloon is placed abaft the engine room. It extends the full width of ship and has seating accommodation for ninety-three. The cabinet work and fittings for the dining saloon and the first class public

TWIN SCREW STEAMSHIP PRINSES JULIANA.



PORT ENGINE OF S. S. PRINSES JULIANA IN THE ERECTING SHOP.

rooms has been designed, supplied and fitted by Messrs. Mutters & Son, of Amsterdam.

The smoke room is on the upper deck, forward, and is accessible by two side passages and a central stairway. The entrance hall on the upper deck is provided with settees and tables and forms a lounge. Immediately aft, and opening off the entrance hall, is the imperial suite of rooms. These consist of a large sitting room, a bed room, and a bath room, all of which are very tastefully finished by Messrs. Mutters. Forward there are rooms for 246 first class passengers, of which sixty will have one-berth cabins, and the others two-berth rooms. A group of two-berth cabins forward is reserved for ladies.

Aft them are berths for 110 second class passengers in rooms for two, four or six. The second class dining saloon seats twenty-eight and is on the main deck, and the second class smoke room is in a house on the poop deck.

The promenade deck is 200 feet long and forms a grand promenade for passengers, while the boat deck affords protection in wet weather. On the boat deck there are six lifeboats and on the poop deck two lifeboats. Each boat is fitted with Welin's quadrant davits. The vessel is fitted with a balanced rudder of the builder's own special type, which is worked by a steam tiller controlled from the bridge.

The anchors are worked by a powerful windlass of Clark Chapman's make.

The speed trials of the *Prinses Juliana* took place on the Firth of Clyde on Sept. 2, 1909. These consisted of progressive runs on the measured mile at Skelmorlie, commencing at 11 knots and gradually increasing until a speed of 22½ knots was attained. The sea speed test was carried out in the North Sea, and between the Hinder and the Tongue the speed obtained was 22 knots.

The Effect of Superheat on the Economy of a Marine Engine as Determined by Tests on the Steam Yacht Idalia.*

BY LIEUT. JOHN HALLIGAN, JR., U. S. N.

On Oct. 11, 12, 13 and 14, 1909, comparative tests were made of the steam consumption of the main engine, feed, circulating and air pumps of the steam yacht *Idalia,* using saturated steam and steam with from 57 degrees to 105 degrees F. superheat.

These tests were conducted by Dr. D. S. Jacobus, under the direction of Mr. W. D. Hoxie, the owner of the *Idalia,* through whose courtesy tests 3, 4 and 5 were witnessed by the writer, representing the Bureau of Steam Engineering.

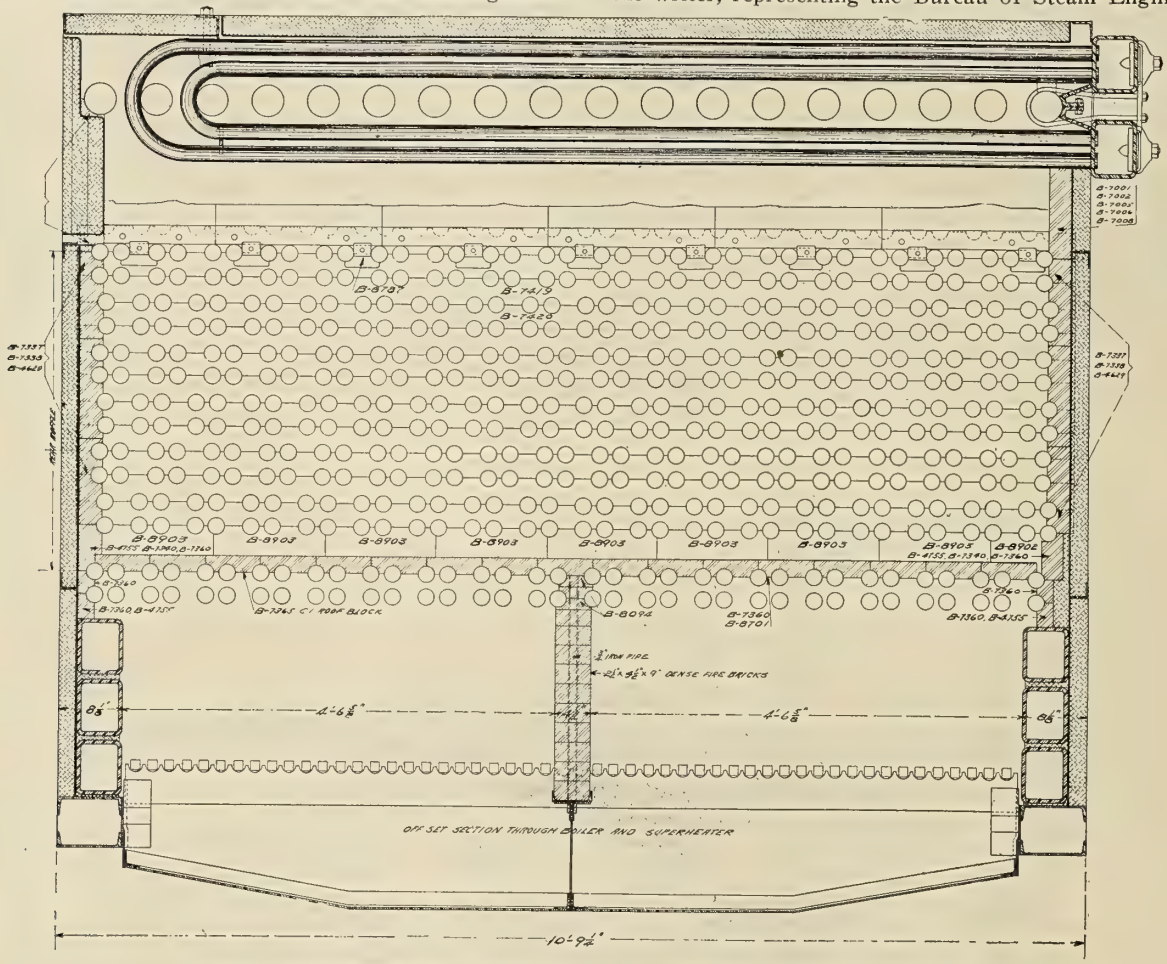


FIG. 1.—TRANSVERSE SECTION THROUGH BOILER, SHOWING LOCATION OF SUPERHEATER.

The *Idalia* is of the following general dimensions: Length over all, 178 feet; length on waterline, 140 feet; beam, 20 feet; depth, 10 feet; draft, 9 feet; gross tonnage, 201; net tonnage, 111.

She is propelled by a four-cylinder triple-expansion engine, 11½ by 19 by 22 11/16 by 22 11/16 by 18 inches stroke, the valves of which are all of the piston type.

Steam is supplied by a Babcock & Wilcox boiler, burning anthracite coal, with 65 square feet grate surface and 2,500 square feet heating surface. A superheater of 340 square feet heating surface is fitted, as shown in Figs. 1 and 2.

The auxiliaries connected with the tests are of the following dimensions: Feed pump, inches, 6 by 4 by 6; air pump (independent), inches, 6 by 12 by 8; circulating pump (centrifugal), inches, 5 7/16 by 5.

Under ordinary conditions of cruising, about 100 degrees of

* From the *Journal* of the American Society of Naval Engineers.

superheat is carried. Except in the case of the dynamo engine, all of the auxiliaries take superheated steam at full boiler pressure. The only lubricant used in the main and auxiliary steam cylinders is fine graphite mixed with water. On the main engine this mixture is introduced by means of a hand-lubricating pump fitted at the throttle, which supplies all the lubricant required for the four main pistons and their respective valves. No difficulty has been experienced in the upkeep of the plant attributable to the use of superheated steam. That the cylinders are in excellent condition is evidenced by the efficiency of the engine as shown on the tests.

The tests consisted of runs under conditions that were practically identical as regards their effect on the results. The main engines and auxiliaries were run at nearly constant speeds. The same indicators, thermometers and gages were used in all the tests, so that the results are strictly comparable.

The steam used by the main engine, the feed, the air and the circulating pumps (all of which are independent) was determined by weighing the condensed steam discharged from the surface condenser, it being pumped from the hot well into a weighing tank mounted on platform scales, from which it was discharged into a feed tank. Temperatures and pressures were recorded at intervals of 15 minutes. Frequent sets of indicator cards were taken, the results of all of which are shown in the tables. New indicators with outside springs were used. The gross and tare weights of each tank full of water were measured, and the net weight of the partially filled tank at the end of each hour was recorded.

The dynamo engine was not run during the tests. The only other auxiliaries—the blower engines—exhausted into the atmosphere.

No attempt was made to record coal consumption or other boiler data, as the tests were too short to afford accurate data of this sort.

The tests were, however, of sufficient duration to give an accurate determination of steam consumption, as is evidenced by the uniformity of the hourly data. The result for any hour of the tests plots very close to the curve shown in Fig. 4.

The superheater shown in Figs. 1 and 2 was designed to provide 100 degrees of superheat; this established the upper limit of the tests. The lower degrees of superheat were obtained by mixing superheated with saturated steam, and by partly shielding the superheater from the hot gases by means of asbestos mill board. It was impossible with the means at hand to secure a lower degree of superheat than 57 degrees.

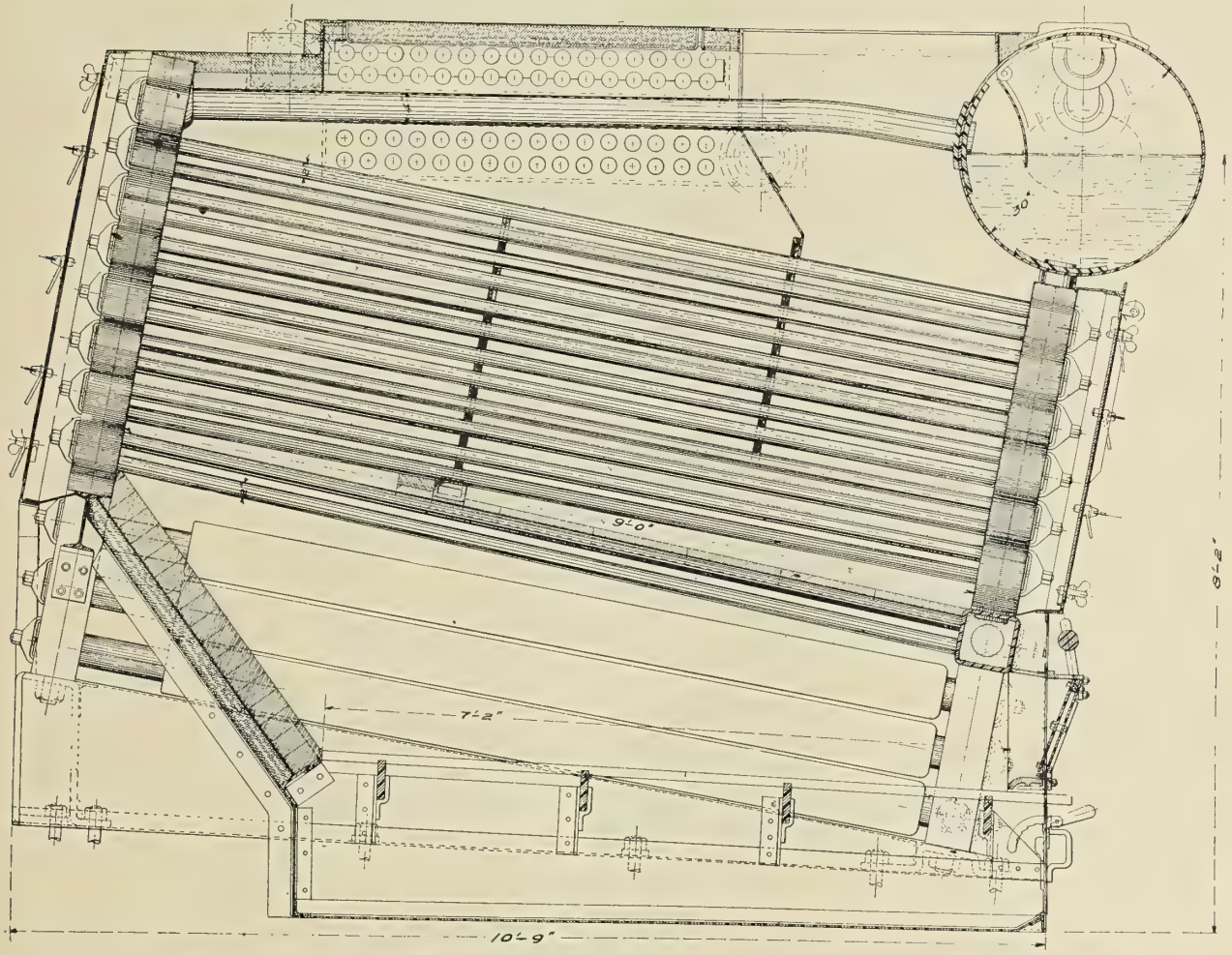


FIG. 2.—LONGITUDINAL SECTION THROUGH BOILER, SHOWING LOCATION OF SUPERHEATER ABOVE EVAPORATING TUBES.

In the test with saturated steam the superheater was completely cut off from the steam line and vented to the atmosphere. The saturated steam was shown to be dry by a throttling calorimeter.

The results obtained are shown in the following tables, and, in the form of a curve, in Fig. 4. It will be noted that the water consumption of the main engine and auxiliaries was 18.3 pounds per indicated horsepower per hour with saturated steam, and 15.5 pounds when steam superheated 105 degrees was used.

Expressing these results as heat consumption per indicated

horsepower per minute we have, respectively, 365.7 and 326.9 B. T. U's. That is, the heat consumption with 105 degrees superheat is 89.4 percent of that when using saturated steam. In other words, the tests indicate that there is a net gain of 10 percent obtained by using 100 degrees F. of superheat. This may be expressed as a saving in coal of 1 percent for each 10 degrees of superheat.

57 degrees F. and 15.3 percent when superheating 105 degrees F.

The tests are directly comparable in the saving of steam due to superheating, as the work done by the main engine and its auxiliaries was practically constant, the exhaust steam being condensed and carefully check-weighed hourly throughout the duration of the trials.

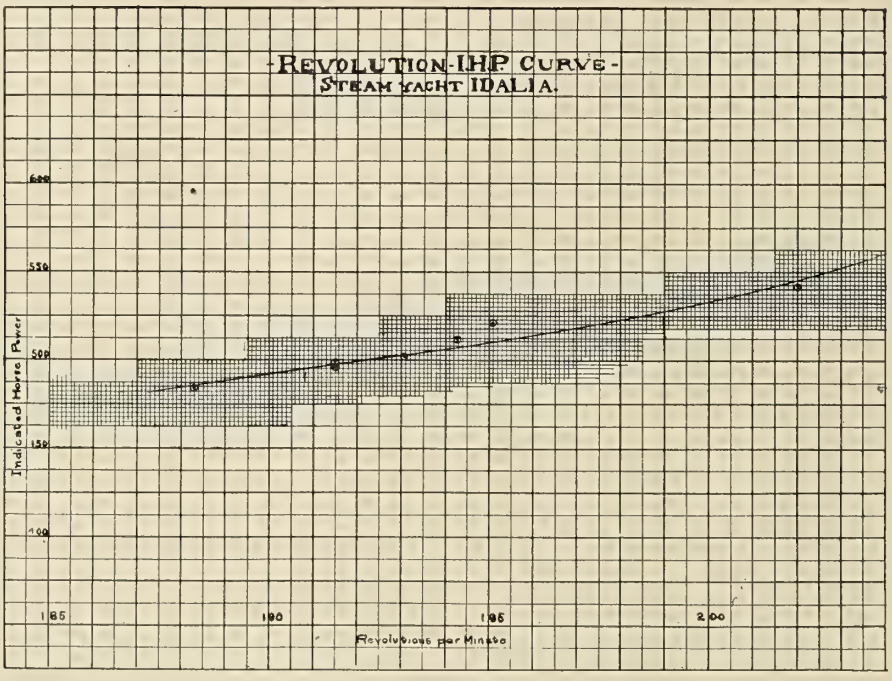


FIG. 3.

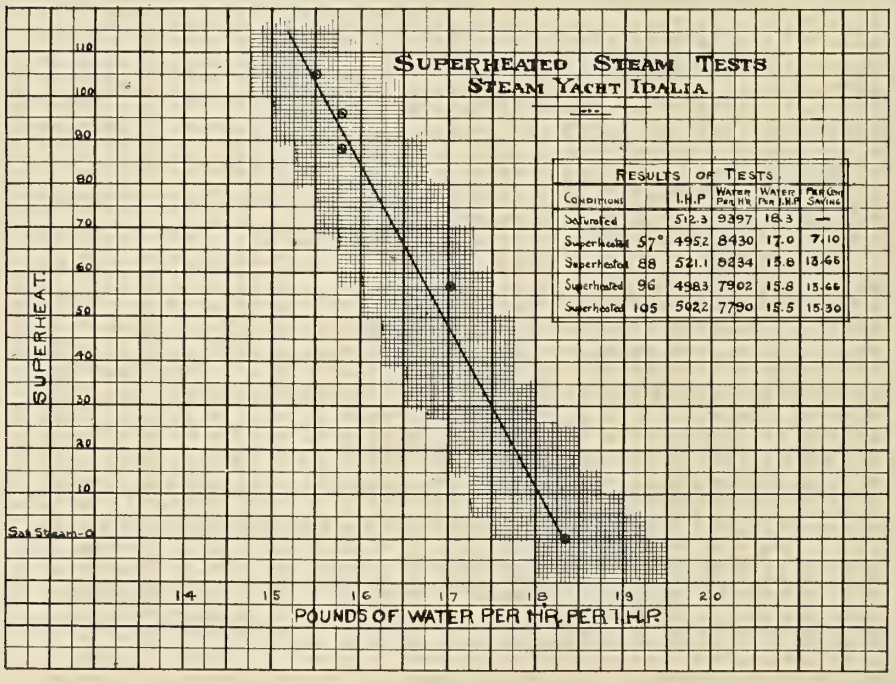

Superheated Steam Tests
Steam Yacht Idalia
Results of Tests
Conditions | I.H.P | Water Per Hr. | Water Per I.H.P | Per Cent Saving
Saturated | 512.3 | 9397 | 18.3 | —
Superheated 57° | 495.2 | 8430 | 17.0 | 7.10
Superheated 88 | 521.1 | 8234 | 15.8 | 13.66
Superheated 96 | 498.3 | 7902 | 15.8 | 13.66
Superheated 105 | 502.2 | 7790 | 15.5 | 15.30
SUPERHEAT
Sat Steam-0
POUNDS OF WATER PER HR. PER I.H.P.

FIG. 4.

Note.—The foregoing tests conclusively prove the economy resulting from the use of superheated steam. In the following table, "Summary of Tests," is found the actual saving in steam per indicated horsepower for different added increments of superheat. These results are plotted in Fig. 4, and the gross saving is found to be 7.1 percent when superheating

Where there are relatively large losses from condensation, the gain due to the use of superheat will be even higher than here shown. This will be the case when running at low powers; so that for the ordinary cruising speeds of naval vessels, a gain of about 12 percent in economy may be expected with 100 degrees superheat.

SUMMARY OF INDICATOR CARDS.

Saturated Steam.

Date, 1909.	Time.	Card.	Mean Effective Pressure.				Water per Hour.
			H. P.	I. P.	F. L. P.	A. L. P.	
Oct. 11....	2:15						
	2:30	1	80	38.0	13.0	12.0	
	3:00	2	75	37.0	12.5	11.5	
	3:15						9,177
	3:30	3	75	37.5	12.0	11.5	
	4:00	4	75	38.0	13.0	12.5	
	4:15						9,214
	4:30	5	86	40.0	13.75	13.0	
	4:45						5,101
	Averages.	....	78.2	38.1	12.85	12.1	9,397

Collective indicated horsepower = 512.34.

SUPERHEATED STEAM, 57 DEGREES.

Date, 1909.	Time.	Card.	Mean Effective Pressure.				Water per Hour.
			H. P.	I. P.	F. L. P.	A. L. P.	
Oct. 14....	2:30						
	2:35	1	78.5	37.0	13.25	12.25	
	2:55	2	84.0	37.5	13.25	12.25	
	3:15	3	81.0	37.5	13.00	12.25	
	3:30						8,571
	3:35	4	70.5	33.0	11.50	11.00	
	3:55	5	80.5	37.0	13.25	12.25	
	4:15	6	75.0	37.0	11.75	11.85	
	4:30						8,290
	Averages.	.....	78.25	36.5	12.67	11.98	8,430

Collective indicated horsepower = 495.2.

SUPERHEATED STEAM, 88 DEGREES.

Date, 1909.	Time.	Card.	Mean Effective Pressure.				Water per Hour.
			H. P.	I. P.	F. L. P.	A. L. P.	
Oct. 14. ..	9:45						
	9:55	1	89.0	35.0	12.00	11.50	
	10:15	2	85.0	33.0	11.66	10.125	
	10:35	3	91.0	37.0	12.50	11.50	
	10:45						7,965
	10:51	4	95.0	37.0	12.50	12.00	
	11:15	5	95.0	37.0	13.65	12.60	
	11:35	6	87.5	37.0	12.10	12.00	
	11:45						8,291
	11:55	7	85.0	36.0	13.75	12.50	
	12:15	8	85.0	35.0	12.50	12.25	
	12:35	9	90.0	36.0	13.00	12.50	
	12:45						8,447
	Averages..	.....	89.17	36.0	12.63	11.89	8,234

Collective indicated horsepower = 521.14.

SUPERHEATED STEAM, 96 DEGREES.

Date, 1909.	Time.	Card.	Mean Effective Pressure.				Water per Hour.
			H. P.	I. P.	F. L. P.	A. L. P.	
Oct. 12....	3:00						
	3:15	1	84.75	...	10.25	10.00	
	3:45	2	91.50	35.00	14.50	12.00	
	4:00						7,842
	4:15	3	93.00	33.75	...	11.00	
	4:50	4	87.50	35.00	13.50	11.50	
	5:00						7,994
	5:04	5	87.00	34.50	13.00	11.00	
	5:26	6	87.70	35.00	12.75	10.50	
	5:30						7,870
	Averages.	....	88.57	34.65	12.8	11.0	7,902

Collective indicated horsepower = 498.27.

SUPERHEATED STEAM, 105 DEGREES.

Date, 1909.	Time.	Card.	Mean Effective Pressure.				Water per Hour.
			H. P.	I. P.	F. L. P.	A. L. P.	
Oct. 13....	2:35						
	3:00	1	...	33.0	11.25	10.25	
	3:15	2	91.0	35.0	13.00	11.50	
	3:35						7,793
	3:38	3	95.0	35.0	12.15	10.75	
	3:54	4	92.5	34.0	12.50	10.80	
	4:10	5	95.0	34.5	12.10	10.50	
	4:29	6	92.5	35.0	12.30	10.90	
	4:35						7,863
	4:48	7	91.0	34.0	12.65	11.00	
	5:05	8	91.0	36.0	12.15	11.00	
	5:24	9	83.5	35.0	11.50	10.80	
	5:35						7,713
	Averages.	....	91.4	34.6	12.17	10.83	7,790

Collective indicated horsepower = 502.15.

MARINE AUXILIARIES.

BY SIDNEY F. WALKER.

The history of the development of auxiliary machinery on board ship practically coincides with the history of the development of the marine steam engine. Since Fulton drove his first steamboat up the Hudson, and since the early steamships crossed the Atlantic, enormous advances have been made in the size of ships, in the speed at which they run, and in the economy at which they are worked. It will be remembered that in the early trans-Atlantic steamers, the *Great Western* and others, the speed was only about 5 knots, and the steam pressure only about 5 pounds per square inch. The ships were also small, and the accommodations such as would be considered in these days almost barbarous. One of the earliest advances made in steam engineering, both ashore and afloat, was the gradual increase of pressure. The 5 pounds per square inch of the *Great Western* has become 250 and 300 pounds in modern ships. The consumption of coal, on the other hand, has steadily decreased. From the 10 pounds or more per indicated horsepower of early days, the consumption has been reduced to 1¼ pounds, and in some cases less in modern steamships.

The increased size and speed of ships have demanded increased size in the engines, and as the size of the engines and the demand for coal and bunker space have increased, the requirements of economy in coal have become more and more pressing. Hence with the advances in size and speed, there has been a development of auxiliary apparatus, designed to effect economy in fuel consumption.

THE CONDENSER.

The condenser was the first apparatus applied to economize fuel on board steamships, but the condenser of the early days and that of to-day are very different pieces of apparatus. The condenser was applied very early by Watt and by others, notably the makers of Cornish pumping engines. In the early days of steamships the jet condenser was employed, because it was simpler than the surface condenser, and because it was

Summary of Tests.

Date. 1909.	Conditions.	Pressures.			Vacuum.	Temperatures.		R.P.M.		Revolutions per Min., Main Engine.	I.H.P. Main Engine.	Water per Hour, Total.	Water per I.H.P.	Percent Saving of Steam.
		Throttle.	First Receiver.	Second Receiver.		Feed.	Hotwell.	Air-Pump.	Circulating Pump.					
Oct. 11....	Saturated.....	190	68.4	9.7	25.5	201	116.0	57	196	194.3	512.3	9,397	18.3	....
Oct. 14....	Superheat, 57°..	196	66.0	9.2	25.9	206	109.5	56	198	191.5	495.2	8,430	17.0	7.10
Oct. 14....	Superheat, 88°..	201	64.3	8.7	25.9	205	115.0	53	196	195.1	521.1	8,234	15.8	13.66
Oct. 12....	Superheat, 96°..	198	61.9	7.8	25.4	202	111.5	54	198	191.5	498.3	7,902	15.8	13.66
Oct. 13....	Superheat, 105°	203	63.0	8.4	25.2	200	111.0	45	197	193.1	502.2	7,790	15.5	15.30

more easily kept in order. With the jet condenser a portion of the water coming from the condenser was employed as boiler feed, but, as will easily be understood, troubles with incrustations of salt in those days were not the least with which the marine engineer had to deal. In those days, also, and for a very long period afterwards, the air pump was driven from the main engine. In fact, the independent air pump has not entirely displaced that driven from the main engine even at this date, though its use is continually on the increase, as it makes for greater economy and, what is of more importance, for greater control of the condenser.

At the present time the surface condenser is the only one that is suitable for marine work. Like other apparatus, it has been gradually developed from very crude beginnings, as the principles upon which condensation takes place have been better and better understood, till at the present day the surface condenser is an exceedingly efficient apparatus. Even with the best form of ordinary surface condenser, however, the results obtainable are not sufficiently good for steam turbine work. It will be remembered that the great advantage which the

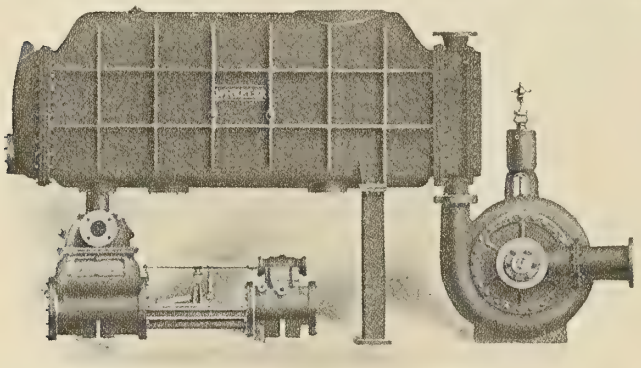


FIG. 1.—WHEELER ADMIRALTY CONDENSER WITH DIRECT ACTING AIR PUMP AND CENTRIFUGAL CIRCULATING PUMP.

steam turbine has over the reciprocating engine is the ability to utilize the steam down to very low pressures, to 28, 28½, and even 29 inches vacuum, if it can be obtained, while the reciprocating engine cannot utilize the steam much below 25 inches vacuum economically. As marine engineers know, the volume of the steam rapidly increases as the pressure falls, particularly below the pressure of the atmosphere. At 25 inches vacuum, for instance, the volume of 1 pound of steam is approximately 150 cubic feet; at 28 inches vacuum it is 350 cubic feet, and at 29 inches it is 641 cubic feet. With the reciprocating engine, the cylinders required to deal with these large volumes of steam would be very heavy, and the valve ports would also require a great deal of care in designing, and would even then probably throttle the steam. With the steam turbine, however, the whole range of pressure can be utilized, no matter how high the vacuum is. As marine engineers are aware, also, the fall of temperature utilized by the mechanical action of the steam is a measure of the efficient use of the steam, and between atmospheric pressure and 29 inches vacuum there is a difference of 130 degrees F., while between atmospheric pressure and a pressure of 250 pounds per square inch the difference of temperature is only 194 degrees F. Hence it is of enormous importance to procure high vacua with steam turbines, and this is not easily obtained with the ordinary surface condenser. The increased quantity of cooling water required is very great, the cost of pumping the increased quantity of water is also serious. Hence, auxiliary forms of condensers have been devised.

For this purpose Mr. Parsons has employed what he calls a vacuum augmenter. He found that it was necessary to increase the condenser surface per indicated horsepower, and to construct the condenser with tubes spaced wider apart than is usual, so that the steam can flow easily among them, and to submerge the lower tubes in the condensed water. The vacuum augmenter was designed to draw off the air and water from the bottom of the condenser by an application of the injector principle. The vapor and air from the augmenter condenser joins the water in the main delivery pipe leading from the condenser, and is drawn off with it by the air pump.

A further development in condensers has been made in the Contraflo, made by Messrs. Richardsons, Westgarth & Company, of Hartlepool. The principle upon which the Contraflo condenser works is that the condensation is carried out in sections. The condenser is divided into two or more divisions, the steam passing through the divisions in series, and the condensed water being drawn off from each division to the hot well as it is formed. The Wheeler Engineering Company and others have also developed forms of surface condensers, designed to give the cooling water the fullest access to the heated surfaces of the pipes on the other side of which the steam is passing, and also to make the whole arrangement compact, an important object on board ship. In the Wheeler Admiralty condenser the condenser itself is carried on pillars above a bedplate, upon which are mounted the air and circulating pumps, the two pumps being worked by a single steam cylinder. The Wheeler Company also makes combined surface condensers and feed-water heaters.

EVAPORATORS.

In order that the boiler may do its best work, the water employed must be as free as possible from dissolved salts. As mentioned above, the old plan of utilizing the water from a jet condenser would be howled out of court at the present time, because the deposit of salts upon the boiler tubes would so seriously affect the working of the boiler as to cause excessive waste and inefficiency. It is the practice in modern steamships to work with fresh water pumped into tanks provided for the purpose when the ship is in dock, and to make up the leakage that is unavoidable by the addition of the necessary quantity of pure water obtained by distillation.

There are a number of evaporators upon the market, but all of them work upon the same principle; that is, the vaporization of sea water. The usual arrangement as made by Messrs. G. & J. Weir, Glasgow; Messrs. Caird & Rayner, of Glasgow; Messrs. Richardsons Westgarth & Co., of Hartlepool; Messrs. Davie & Horne, of Glasgow, and Messrs. Royle,

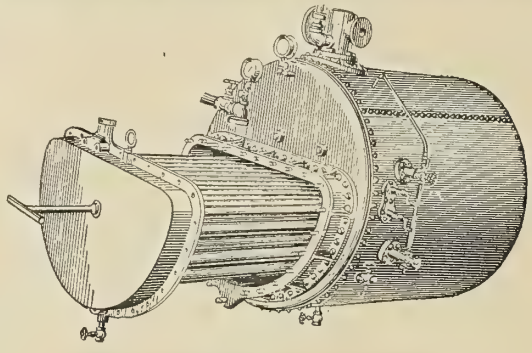


FIG. 2.—WILLIAMSON BROS.' EVAPORATOR.

of Manchester, consists of what is practically a steam boiler surmounted by a steam dome. In that of Messrs. Weir, there is a coil of hard drawn copper pipe fixed inside a casing, the whole being surmounted by a dome-shaped vessel. Steam is made to pass through the coil of pipes, and sea water is pumped into the surrounding space. The heat from the steam pipes causes the water to evaporate, and the steam formed is collected in the dome-shaped space above. In Weir's evaporator the coils are fixed horizontally. In Messrs, Caird &

Rayner's evaporator the steam coils are also fixed horizontally, but there are two sets sandwiched together. In the Morrison evaporator, made by Messrs. Richardson-Westgarth, the coils are in a vertical plane. In Messrs. Davie & Horne's evaporator, the coils are in a horizontal plane, but they are formed into a hemispherical shape, and occupy the lower portion of a spherical chamber. In Messrs. Royle's evaporator, the steam tubes are of a special "Row" pattern and are fixed vertically.

In all forms of evaporator, the question of cleaning the outside of the coils is an important one, owing to the incrustation of salt, which takes place from the sea water as the evaporation proceeds. Arrangements are made, therefore, in all of them to inspect and clean the coils. In Messrs. Royle's the bank of tubes is fixed upon the door of the evaporator chamber, and when the door is swung open, the tubes are easily accessible for cleaning. In Messrs. Weir's evaporator, the door is made to swing open, and the tubes can then be withdrawn to be cleaned. In the Morrison apparatus, the tubes are withdrawn on opening the door. In the evaporator of Davie & Horne, the arrangement is rather different. The spherical evaporating chamber is made in two halves. One half forms the door, and is lifted right away; the tubes can then be revolved upon the upper connecting tube as a pivot.

In the Williamson evaporators (Fig. 2), made by the Williamson Bros. Company, Philadelphia, Pa., the steam circulates through a nest of straight brass tubes expanded into tube heads, covered at each end by steam bonnets. The salt water circulates around the tubes in a vertical cylindrical shell. The tubes are horizontal in the bottom of the evaporator, and can readily be removed for cleaning.

A somewhat different type of evaporator is manufactured by the Griscom-Spencer Company, New York. The steam circulates in vertical spiral coils, of which there are a great number, arranged in a vertical cylindrical shell. The coils are of small diameter, seamless, drawn-copper tubing, and are joined to the headers by screwed, ground union joints without packing or gaskets. It is claimed that this constriction insures exceptional elasticity and freedom from accidents, while at the same time the coils are not subject to scale deposits.

The question of the use that should be made of the distilled water produced by the evaporators is important. It may be delivered to the low-pressure receiver of the main engines; it may be delivered straight to the condenser and carried to the hot well with the condensed water, or it may be delivered to the hot well, or feed tank direct. The last method is the most economical, as all of the water that has been evaporated is usefully employed, and the heat which is contained in the steam that has been formed is delivered to the feed water. When the steam from the evaporator is delivered to the condenser, the heat that was employed in evaporating it is practically lost, and a large portion of it is also lost when the steam is delivered to the low-pressure receiver. Messrs. Richardson-Westgarth give the difference in economy between delivering the evaporator steam directly to the feed water and to the low-pressure receiver and the condenser, respectively, as 1 to 12.3 and 16.5. In other words, the cost of fuel to evaporate a given quantity of make-up feed water would be 12.3 times as much if delivered to the low-pressure receiver as when delivered directly to the feed water, and 16½ times when delivered to the condenser.

COMPOUND EVAPORATORS.

An arrangement for evaporating water that is widely used on shore where pure water is required, and is also gradually making its way on board ship, is what is practically a compound evaporator. There are two evaporators exactly alike. Live or exhaust steam is supplied to one evaporator, but the steam formed by evaporation from the sea water in the first apparatus is caused to circulate through the steam heating pipes of the second apparatus on its way to the hot well or to the condenser. The compound evaporator is applicable both to evaporation for feed make-up, or to distilling water for drinking purposes, and it will be seen must be a source of economy.

FRESH-WATER DISTILLING APPARATUS.

The supply of fresh water is one of the most important requirements on any ship, and it is met by an extension of the principle upon which the evaporator is constructed. The fresh-water distilling apparatus for the supply of drinking water consists of an evaporator, plus some simple form of condenser. The steam, in place of being taken to the feed water, or to the low-pressure cylinder, or the condenser, is taken through a condenser, of which there are various forms, all on the same principle. The steam usually passes through a coil of tubes, the outside of which is exposed to the action of cooling water.

THE AIR PUMP FOR CONDENSERS.

The air pump is one of the most important auxiliaries on board ship. The modern air pump used at sea is almost universally of the Edwards type, a section of which is shown in

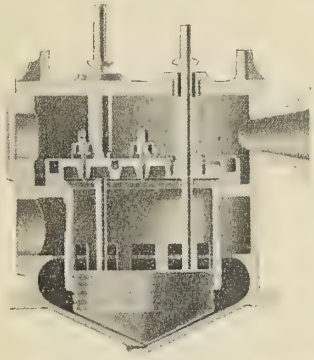


FIG. 3.—SECTION OF EDWARDS AIR PUMP.

Fig. 3. It will be remembered that one of the great difficulties in connection with the condenser is the removal of the air, which comes over with the steam from the exhaust. Water dissolves air, and any water which is employed for boiler purposes carries a certain quantity of dissolved air with it into the boiler. The dissolved air is driven off as the boiler gets under steam, this being one of the peculiar properties of gases and liquids. Water has the property of dissolving most gases, but its ability to hold them in solution decreases very rapidly as the temperature rises. Hence, as the water in the boiler rises in temperature, the air is driven off and is carried over with the steam into the cylinder, and thence to the condenser. Mr. Charles Parsons states that he has found the air coming over from the engine with the steam has a blanketing effect upon the particles of water. That is to say, the presence of a layer of air around a globule of steam prevents the extraction of heat from the steam necessary to its conversion into water.

The development of the air pump has taken place on two lines. In the early days of steamship propulsion, and right up to the present day, in a great many ships, the air pump was driven from the main engine. Modern practice is to drive independently by a separate engine.

The other development of the air pump has been in the construction. The old form was of the bucket type, and Messrs. Weir, who have done so much in steam engineering for ships, have developed the old bucket pump and claim to produce an equally good result with the valveless form. In the Weir pump, which is shown in Fig. 4, there are three

valves, a suction valve, a valve in the piston, and a delivery valve, and it is claimed by Messrs. Weir, as the writer understands, that the construction of these valves, which are of the Kinghorn type, enables them to produce at least as good a result as in the valveless form of pump. In the complete single, or monotype air pump, as shown in Fig. 4, the water chamber is formed by a cylindrical casting and supports the steam cylinder above by stay-rods. The twin type of air pump appears to be a great favorite.

The importance of the independent drive of the air pump can hardly be overestimated. Modern practice in engineering is to have independent control of every part of the apparatus. It means economy.

In the Edwards air pump, which is made by a large number of firms, the claim is the absence of foot and bucket valves. The great feature of the pump, as will be seen, is the conical shape of the piston and water chamber. In the Edwards

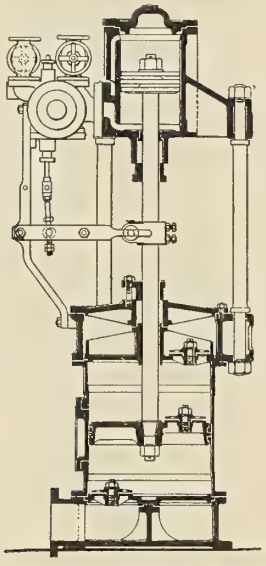


FIG. 4.—WEIR'S MONOTYPE AIR PUMP.

pump, the water formed by condensation of steam flows continuously by gravity from the center into the conical-shaped chamber forming the base of the pump. The water is forced upwards by the descent of the conical bucket, which is virtually a piston, and on the upward motion of the bucket it is forced through the valves at the top of the barrel. It is claimed for this pump that it is in no way dependent on the pressure in the condenser to drive the water into the pump, and consequently that an increase of speed in the pump does not impair its efficiency. The Wheeler Condenser & Engineering Company make the Wheeler Edwards air pumps in single, twin and triplex form.

CIRCULATING PUMPS.

The circulating pump has developed very much on the same lines as other pumps. The principal advance has been in details of manufacture. As marine engineers are aware, there has been practically a revolution in constructive methods in engineering during the past twenty-five years. Twenty-five and thirty years ago the average mechanic thought he had done very well indeed if he fitted to 1/16 inch, and was more than proud if he fitted to 1/32 inch. In these days fitting to 1/1000 inch is nearer the universal practice. Machine tools of all kinds have been developed, and it is only fair to say that America has led the way in their development. The American method of turning out a number of parts of any apparatus, all exactly to gage, and that a very close gage, now practically rules the world of engineering manufactures. It has led to very much better construction, very much better fitting, and to the possibility of using apparatus that could not be used before.

The ordinary plunger pump is still used for circulating water, but it is giving way to the centrifugal pump. The centrifugal pump has also been enormously improved during the last twenty years. Both forms of pump, however, are used.

ENGINES FOR DRIVING AUXILIARY MACHINERY.

Another very important development that has taken place in connection with marine auxiliaries is in the matter of the engines employed for driving them. In the early days single, open-type engines were almost universally employed. They were naturally wasteful in steam and troublesome to look after. Gradually the compound engine has displaced the single engine, and occasionally triple-expansion engines have been employed. Another and a more important development has been the use of the enclosed engine. It will be remembered that enclosure of the crankshaft enables very much higher speeds to be employed than in the open type engine, and this combined with the advances that have been made in the methods of lubrication of high-speed engines has led to their general employment for driving auxiliaries on board ship.

FEED-WATER HEATERS.

Another source of economy which is now almost universally employed, and that has gradually come into use, is the feed-water heater. There is not only an economy in delivering water to the boiler, at the temperature of the water already there, when it can be done at the expense of heat that would otherwise be wasted, but it also adds to the efficient working of the boiler itself, to avoid the entrance of bodies of water

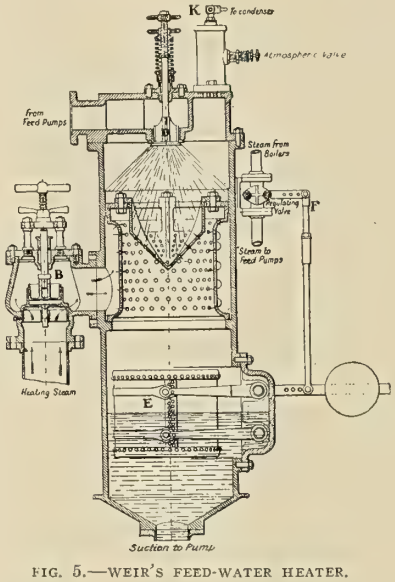


FIG. 5.—WEIR'S FEED-WATER HEATER.

at intervals at a lower temperature. As marine engineers know, for the efficient working of a boiler, the action must be continuous. There must be water continually being heated at the surfaces of the tubes and furnace crowns; this water must be continually passing upwards and giving place to other water to be heated in its turn and pass upwards, and so on. So long as the whole body of the water present is of nearly the same temperature, allowing for the difference in distance from the source of heat, this action should go on uninterruptedly. If, however, a cold douche is given to some part of the boiler circulating system, the circulation of the water must be interfered with, and the results must be inefficient working, more trouble to the engineer and fireman and increased consumption of coal. Hence have developed various kinds of apparatus for utilizing the heat of the exhaust steam.

There are a large number of feed-water heaters on the market, but with few exceptions they are constructed on very much the same lines. There is an outer containing vessel, usually cylindrical in form, with a vertical nest of tubes held between two plates fixed near the top and bottom of the containing vessel. The water passes through the tubes, the outside of the tubes being exposed to steam, which is allowed to pass over them on its way to the condenser. In some forms, however, the reverse arrangement is made. The steam passes through the tubes and the water circulates outside. The feed-water heater is sometimes included in the same containing vessel as the condenser. As mentioned above, the Wheeler Engineering Company make a combined feed-water heater and condenser, the steam to be condensed passing through the feed-water portion of the apparatus first, and then to the condensing portion. Other firms, the writer understands, have similar arrangements.

The direct-contact feed-water heaters of Messrs. G. & J. Weir are constructed upon different lines to those described above. As will be seen from Fig. 5, in the Weir apparatus there is an outer containing vessel and an inner perforated

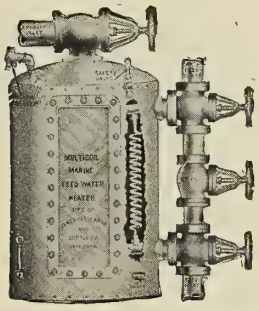


FIG. 6.—THE REILLY MULTICOIL FEED HEATER.

cylinder, into which a perforated cone projects from above. The annular space between the perforated cylinder and the containing vessel forms a steam space, and the steam being delivered to this space passes through the perforations in the inner cylinder, and there meets a stream of water coming down from above. As will be seen by the drawing, the water is forced into the upper portion of the containing vessel under pressure. It is sprayed out on entering the space above the perforated cylinders, and it is further broken up by the perforated cone, which is held inside the perforated cylinder. It is claimed by the makers that the breaking up of the water into spray and the mixing with the steam gives a high economical heating effect, the whole of the heat of the steam being delivered to the water. The lower portion of the containing vessel, as will be seen from Fig. 5, forms a receiver for the heated water. In this receiver is a float supported upon a lever and opposed by a balance weight. The outer portion of the lever controls a valve supplying steam to the feed pumps. The speed of the pumps is thus controlled in accordance with the quantity of feed water delivered to the heater.

In addition to the above, attached to the upper portion of the apparatus, is a valve leading either to the atmosphere or to the condenser. It is claimed by the makers that as the pressure of steam in the heater is less than the pressure at which the water is delivered, the heating of the water and the lowering of the pressure liberates the air in the water, which passes off by way of the air valve mentioned, either to the atmosphere or to the condenser, the feed water being thus rendered non-corrosive.

The steam for the Weir feed-water heater is taken from the low-pressure receiver of the main engines and from the exhaust of the auxiliary engines.

The construction of the Reilly Multi-coil Feed-Water Heater, manufactured by the Griscom-Spencer Company, New York, as shown in Fig. 6, is similar to that of their evaporator previously described.

FEED-WATER FILTERS AND GREASE EXTRACTORS.

Another important auxiliary that has been found necessary, and that has led to further economy, is the feed-water filter

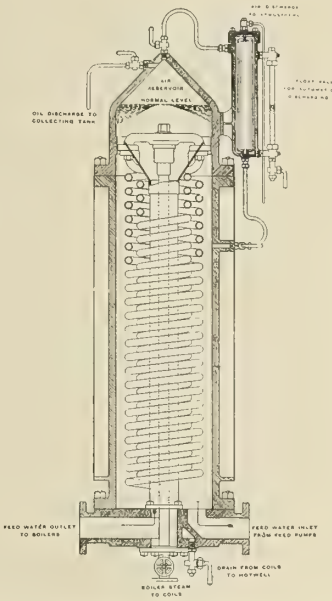


FIG. 7.—MORRISON FEED HEATER AND FILTER.

and grease extractor. Experience has shown that a thin film of oil, on furnace crowns for instance, offers such a large resistance to the passage of heat through it that the plate is heated to a high temperature when the ship is under steam, leading to rapid wearing out. The same thing, of course,

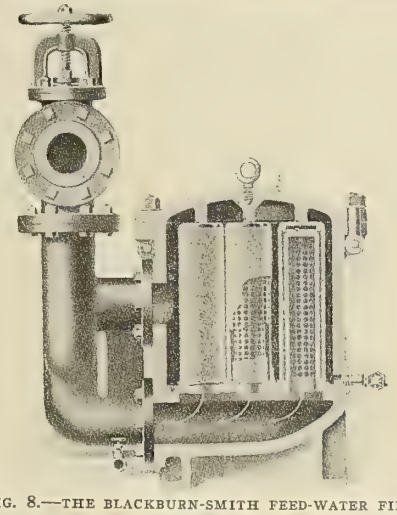


FIG. 8.—THE BLACKBURN-SMITH FEED-WATER FILTER.

applies to boiler tubes, no matter what the form of the boiler may be, and to other surfaces, across which heat has to travel in the ordinary working of a boiler. As explained above, every gas has the property of absorbing the vapor of other substances. Steam behaves in this matter as a gas, and it absorbs a certain quantity of the vapor of the lubricant, carrying it over with it to the condenser, sometimes depositing upon the condenser tubes and leading to inefficiency there, and often being carried forward through the condenser to the hot well and back to the boiler. Practical marine engineers discovered a good many years ago that this was the cause of a good deal

of the deterioration of boilers at certain portions of the heating surface.

To meet this difficulty oil separators and oil filters have been introduced. The oil separator is very similar to the steam separator. As with other apparatus there are many forms on the market, all on very much the same lines; in all of them the steam is allowed to expand inside a chamber in such a manner that its velocity is very much decreased, and baffles or other arrangements are placed in the chamber in the path of the steam, the object being to arrest the globules of oil, and to cause them to drain down into a well provided for them. The oil separator and feed-water heater are sometimes united in one apparatus. In the Morrison feed-water heater, made by Messrs. Richardsons, Westgarth & Company, which is shown in Fig. 7, it is claimed that the air and oil are removed from the feed water in the process of heating. There is a

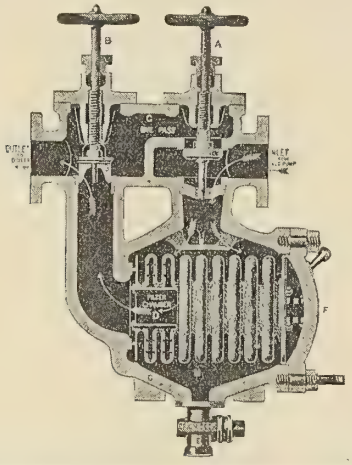


FIG. 9.—SECTIONAL VIEW OF THE WILLOCK-REID FILTER.

central tube surrounded by a coil of steam pipe, heated by steam from the boiler or any convenient source. The feed water to be heated enters the annular space in which the steam coils are fixed, passes upwards to a conical chamber at the top, and thence down through the central tube to the bottom of the vessel and out to the boiler. It is claimed that the air and oil are carried upwards into the conical chamber at the top, the air being carried off to the atmosphere and the oil discharged periodically by a cock provided for it. The North Eastern Marine Engineering Company, of Sunderland, make a somewhat similar apparatus. There is central tube surrounded by a steam coil and a dome-shaped space above. The arrangement is, however, different from that in the Morrison apparatus. The feed water enters the central tube first, passes upwards, and then down through the annular space enclosing the steam coils and thence out to the boiler. The space above is employed to clear off the oil and water by means of the scum valve. The feed-water filter is a natural adjunct to the feed-water heater and oil separator. With even the most perfect separator it is not possible to ensure that the oil shall always be removed, and, as marine engineers know, a very fine film of oil upon the boiler tubes or furnace crowns will cause a good deal of trouble. It is now usual, therefore, to interpose a filter in the path of the feed water before delivering it to the boiler. Messrs. Willock, Reid & Company make such a filter, a sectional drawing of which is shown in Fig. 9. As will be seen from the drawing the feed water enters by the inlet provided for it. Its entrance into the filter is controlled by a valve, and it is made to pass through the filtering material and thence out to the boiler, the oil being absorbed by the filter on the way. A branch cock is provided for letting the oil and condensed water off from time to time, and the filter material can be changed when required by removing the door shown on the right. A by-pass is provided to enable the apparatus to be cut out if desired.

The Blackburn-Smith feed-water filter and grease extractor, shown in Fig. 8, is manufactured by James Beggs & Company, New York. It consists of a chamber containing a number of cartridges which compel double filtration through two separate and independent surfaces. Each cartridge consists of two concentric cylinders of heavy perforated brass tubing covered with linen Terry. The apparatus can be easily cleaned by removing the outer cartridges and replacing them by spare ones, suitably covered with the filtering material.

Other types of filters, as manufactured by the American Steam Gauge & Valve Company, Boston, and Alexander Miller & Company, Jersey City, are described elsewhere in this issue.

BOILER-FEED PUMPS.

The boiler-feed pump is also an important apparatus, and it has undergone a process of development, in common with other auxiliaries, to enable it to keep pace with other advances. The requirements for pumping water at 200 degrees F., for instance, are different from those of a pump for water at the ordinary temperature of 60 to 80 degrees. The usual arrangement now is, the pump is fixed vertically, with the pump barrel below, and a steam cylinder above, the steam cylinder being supported by rods fixed to the top of the pump barrel. The feed pumps are sometimes arranged in duplicate. The important points are: the proper construction of the pump barrel and bucket, and the construction and control of the entry valve to the steam cylinder. In Messrs. Weir's feed pumps, the pump barrel is made of close-grained cast iron, fitted with a gun-metal lining in the barrel, or entirely of gun metal as required. The pump bucket is made of gun metal fitted with ebonite packing rings. The valves and seats are made of special manganese bronze, working on a gun-metal seat. The piston and pump rods are of cold-rolled man-

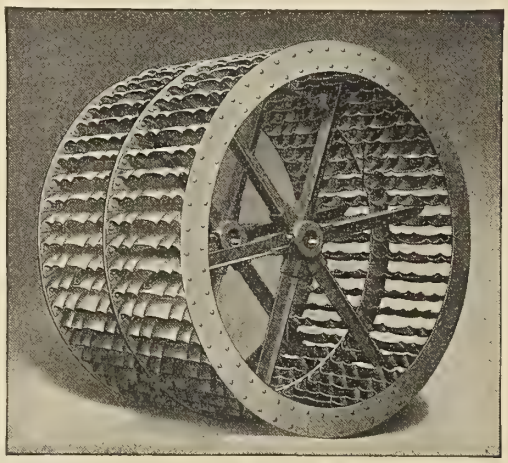


FIG. 10.—THE STURTEVANT MULTIVANE FAN FOR FORCED DRAFT.

ganese bronze. The main valve admitting steam to the steam cylinder is an ordinary slide valve moving horizontally, but there is an auxiliary steam valve controlling the motion of the main steam valve and moving vertically on a flat face.

DRAFT APPLIANCES.

Both forced draft and induced draft have been largely introduced for marine work. By forced draft is meant the delivery of air to the ash-pit under pressure, in place of relying upon the draft caused by the difference between the weight of the gases in the funnel and the corresponding column of air outside. By induced draft is meant the provision of a suction fan on the funnel side of the boiler drawing the hot

gases through the furnace, and causing a corresponding draft of air to follow through the ash-pit, grate bars, etc. It is found that by increasing the pressure at which the air is delivered to the fuel, larger quantities can be burnt upon a given grate area, and that the combustion of the fuel is carried on more economically. In addition, there is the important fact that either forced draft or induced draft renders

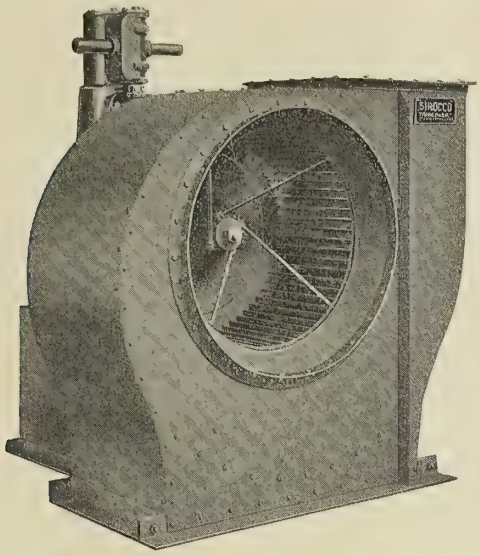


FIG. 11.—SIROCCO TOP VERTICAL DISCHARGE EXHAUST FAN FOR INDUCED FOR HIGH-PRESSURE FORCED DRAFT.

the boiler furnace practically independent of the funnel. The funnel need only be high enough and large enough to carry off the flue gases at such a height above the ship's deck that they will not be a nuisance to those on the deck.

With forced draft, either the stokehold must be closed in and the air delivered to it, or air pipes must be led from the

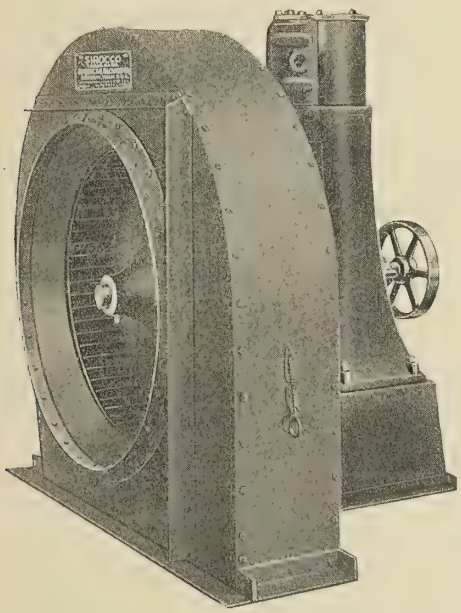


FIG. 12.—SIROCCO BOTTOM VERTICAL DISCHARGE FAN OF SPECIAL WIDTH DRAFT AND VENTILATION.

fan to the different ash-pits and the air delivered through them. Fans used for both induced and forced draft are of the centrifugal type. The propeller fan is of no use for work of this kind. The pressure required with both forced and induced draft may be as much as 2 inches water gage, or, in special cases, even more, and the propeller fan is only able to produce a pressure of a small fraction of an inch of water gage. Almost any form of centrifugal fan will answer both for forced and induced draft, but fans employed for induced draft must be wider than those for forced draft to accommodate the larger volume of gas at the higher temperature, and in addition they must be arranged as far as possible to withstand the action of the flue gases.

Heating the air for the furnaces has also been introduced by Messrs. John Brown & Co., of Sheffield, the air being caused to pass through a nest of pipes on its way to the ash-pit, the pipes being exposed to the heat of a certain portion of the flue gases. Among those making fans for induced and forced draft may be mentioned Messrs. Davidson & Co., of Belfast, Messrs. Drysdale & Co., of Glasgow, and others.

AUXILIARIES FOR OTHER PURPOSES.

In addition to the auxiliaries described above, which form part of the main steam propelling plant, the development of the passenger service and the increased size of ships has demanded other auxiliaries. Electricity is now largely employed on board ship, both for lighting and power, and among the most important steam auxiliaries are the engines driving the dynamos. Cold storage is also an important adjunct to the equipment of every passenger steamer of note, and of every man-of-war above a certain size, and again among the important auxiliaries are the engines or motors for driving the cold-storage compression plant. The modern passenger steamship also is very much like a hotel. Baths and lavatories form an important part of its equipment, and this again demands a supply of hot and cold water, the pumps for which are again among the important auxiliaries. The fire pumps, again, the bilge pumps, and others, are also necessarily larger and more powerful than in past times.

The question of the ventilation of the ship has also forced itself upon designers and engineers, and an important part of the auxiliary machinery is employed in this work. All these, however, have been described in previous articles by the present writer.

The New York Motor Boat Show.

The Sixth Annual National Motor Boat Show was held at Madison Square Garden, New York City, Feb. 19 to 26, under the auspices of the National Association of Engine and Boat Manufacturers. Greater interest than ever before was manifested in the show this year, and both the attendance and the amount of business transacted was far ahead of anything which has been done in previous years. The exhibits were exceptionally good, and covered the whole range of motor boats, from the smallest power dory up to 40-foot cruisers, as well as engines of all sizes up to 300 horsepower. From the orders placed it is evident that the motor boat propelled by an internal-combustion engine is fast displacing the expensive steam yacht. This is a natural development, since the motor boat gives practically the same accommodations with a smaller and less costly hull than a steam yacht, and the expenses of operating the boat are also less, since the crew is reduced to a minimum and the up-keep of the machinery is not so expensive. There still seems to be little activity, except in an experimental way, with other fuels than gasoline (petrol) for motor boats. Crude oil engines and producer gas are not yet being adopted to any great extent, but the increasing use of motor boats for commercial purposes and the increasing size of installations indicate that the cheaper fuels will soon be in demand, and as soon as such a demand is felt the development of engines to use these fuels will be rapid.

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"The Vanadium Bell was struck 12 blows with the face end of a sledge hammer at 'A' (as marked in above sketch) without any evidence of failure. It was then struck 30 blows at 'B' without any evidence of failure. The bell was then placed under the steam hammer and distorted in the shape shown in above sketch without any evidence of failure.

"The bell made from our standard mixture was struck 12 blows with the face end of a sledge hammer at 'A' without any evidence of failure. It was then struck twice at 'B' with the peen end of the sledge and cracked at the second blow. The bell really cracked with one blow, as the first blow scarcely nipped the edge of the bell, while the second blow, which was a true one, cracked the bell to the extent shown in sketch No. 2."

Write for our booklet on "Vanadium Metals in Marine Construction."

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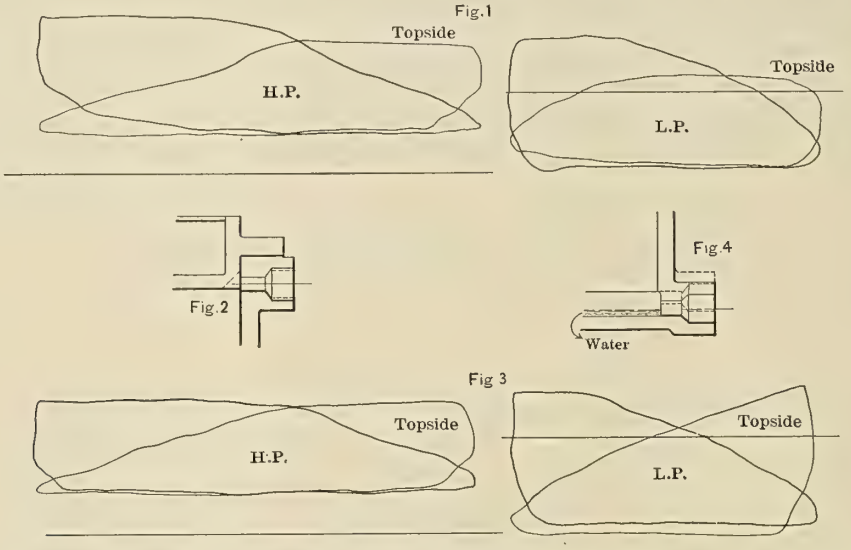
PRACTICAL EXPERIENCES OF MARINE ENGINEERS.*

Incidents Relating to the Design, Care and Handling of Marine Engines, Boilers and Auxiliaries; Breakdowns at Sea and Repairs.

Defective Indicator Diagrams.

By the workmen the indicator gear of a steam engine is often regarded as a superfluous part. They frequently consider that it has nothing to do with the success of the running of the engine, as it is generally removed after the trial trip. So the foremen must give special care to the steam passages to the indicator cocks, seeing that these are clear and cleaned from core sand, by means of which the piston often grips in the indicator cylinder. More depends upon the indicator gear than most workmen realize, as on a coal trial the quantity of fuel burnt per horsepower per hour will be too much, when the indicator diagrams indicate less horsepower than is exerted on the pistons of the engines.



The first high-pressure and low-pressure diagrams of the triple expansion engine of the tug *M. H.* are given in Fig. 1. It is seen that the pressure on the top sides of both pistons is less than on the bottom sides. It was thought that something was wrong with the steam distribution, but the first thing to be examined was the steam passages to the indicator cocks. It was found that the cylinder cover partly covered the holes in the cylinders (Fig. 2.) The covers were altered, as shown by the dotted lines, and then another set of diagrams was taken. These are shown in Fig. 3, and it will be seen that they are so much better that an alteration of the steam distribution is unnecessary.

On the bottom sides of the low-pressure cylinders the steam passages are often restricted by the condensation water (Fig. 4), therefore it is recommended to have the holes as high as possible, as indicated by the dotted lines. D. K.

Lubrication.

Although as much attention should be given by the engineer of a boat to lubricants as to boilers or engines, he is somewhat handicapped in this respect, inasmuch as he has no proof of the quality of the lubricants sent on board. They may appear to be of the best value, and yet be composed of very poor oils or greases. The fact of dealing with reliable firms always, or almost always, removes the necessity for experience in testing oil, but a simple method which could be applied under all circumstances, and in all ports would be of great advantage to the engineer, especially in the case of vessels trading abroad, and having to obtain supplies at any available port.

The truth of this contention may be evidenced by the recital of a series of troubles which occurred on a boat which, unfortunately, ran out of the home supply and had to replenish by a stock of oil from foreign sources. The oil ordered for the use of the engines was of a well known make, with a big reputation, but succeeding events showed that either the oil had been adulterated or tampered with, inasmuch as it was almost useless as a lubricant. The first evidence of trouble was that the engines began to heat up mysteriously in the middle of a long voyage, the crank shafts became hot, the connecting rod top ends subsequently followed suit, and then the guides joined the participants in the trouble. It soon proved to be no ordinary heating up which had set in. Extra care and nursing were resorted to. Previous to this trouble the engines had been run for years without water in the bearings, but it soon became necessary to turn on the water to the bearings. Finally a stop was made and an examination carried out of the bottom ends. These appeared to be in good order and did not show any broken pieces of white metal, or anything which would account for the heating. They were therefore replaced and adjusted to take up the wear and tear, and a fresh start was made. The heating of the bearings still went on, and everybody was at a loss to account for the trouble. Oil was used in large quantities, and a very careful system of nursing was resorted to. It was, however, of no use, and this trouble had its natural effect on the engines, further wear and tear being experienced. Another stop had soon to be made and the bearings were again taken to pieces and examined, adjustment and replacement followed, and the engines were restarted.

* We pay for these articles.

This series of heating and stopping went on for some days and did the engines a good deal of harm. During this time everybody was on the alert to try and leave the engines cooler than they were at the beginning of the watch. Incidentally a good deal of ill-feeling was caused by the trouble, and each engineer was suspicious of the others, and blame was attached to each and all in turn. This did not mend matters, and a further stop had soon to be made. The top and bottom brasses were taken down and rebedded and adjusted. Attention was also given to the guides and eccentric straps, which were the last to start and give trouble. This occupied 16 or 18 hours, and everybody was worn out by the fight.

After a start was made again, the oil was mixed with a small proportion of cylinder lubricating oil. The effect of this was almost instantaneous. In a few hours the engine was running as it formerly used to do, and the trouble disappeared, the only care necessary being to watch the bearings very closely and oil them frequently to bring the surface up to perfection again.

The only explanation which could be advanced for the fact that the oil was of no use was, that it had decomposed with the heat of the engine room and required some attention to make it retain its lubricating properties in a high tropical temperature. Cylinder oil is, of course, specially designed for high temperatures and therefore answered well, but the fact remains, however, that the oil supplied should have been good enough for any climate, and it was impossible to tell that it was a poor oil by its appearance. All the usual tests were satisfactory; it lathered when mixed with water and stirred, it had a golden color when viewed running from a spout, and a bluish tint when standing in a vessel. It was not too viscous and not too thin. It would therefore be interesting to have a good reliable test for lubricating oil which a marine engineer could apply on board ship before making the test on his engines.

If, however, the writer should be so unfortunate as to have a similar experience in future, he will, after satisfying himself that the heating is due to bad oil, mix it with good cylinder or castor oil according to the supplies at hand. The proportion used in the above case of cylinder oil or ordinary oil was about one-third. Cylinder oil is, of course, far too thick to be used by itself, and there is often a lack of it, as perhaps only five or ten gallons are kept on board at one time. If, however, the question of economy is studied, it will be seen that it is best to use even cylinder oil to improve the lubricating properties of ordinary oil, as during the time the above trouble was in progress three times the quantity of oil allowed for the engines was used. This was not due to any more or less automatic pipes or syphons or other labor-saving devices, as the oiling in this ship was always done by the engineers by hand.

T. S. Martin.

Cementing a Broken Steam Pipe.

New uses for cement are being found every day on board ship, one of which the following experience with a broken steam pipe illustrates. Several years ago less precaution was taken in the manufacture of steam pipes than is taken to-day, especially as regards the uniformity and tensile strength of the metal in the pipe, and consequently fractures were not uncommon.

Such an accident happened aboard one of the L. & H. liners bound for the west coast of South America. The pipe in question was the forward hoister line, which extended up through the fiddley and laid uncovered and exposed its entire length on deck to the different hoisters. This detrimental feature, of course, necessitated the closest watch when using the line in cold climates to insure that the pipe did not collect water at certain times unawares. However, the deck crew was using the hoisters in rigging the derricks when nearing Punta Arenas, in the Strait of Magellan, in the month of July, which is noted as a very cold month at that port. Apparently there were no immediate signs of danger with the hoister line, but nevertheless the pipe burst at a supposedly strong place. The fracture was in a bend, but away from all faulty positions.

This necessitated the shutting down of all the forward engines, and repairs were started in the usual manner. The crack extended in a lengthwise direction about 10 inches, then partly circumferential for about 3 inches. In repairing, several suggestions were given, and the quickest for a trial was to wrap some high-pressure sheet packing around the pipe, then wind this closely and tightly with heaving line. To our regret this lasted less than an hour when it blew out the sheet packing, consequently a more durable method had to be employed, and here is where the cement played the important part.

New sheet packing was wrapped around the pipe again, and securely bound with wire wound very close together, then a wooden box was made about 20 inches long, and allowing about 2 inches clearance all around the pipe. See Figs. 1, 2 and 3. The box was nailed together around the pipe, with the

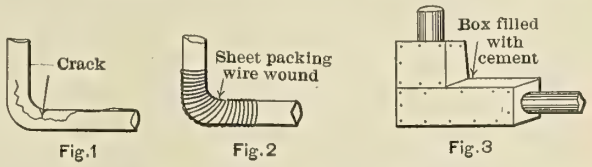


Fig.1 Fig.2 Fig.3

top open. In this the usual mixture of cement was poured until the box was completely filled. The steam valve was "cracked," admitting only enough steam to keep the pipe hot, which hastened the drying of the cement. The cover of the box was left off for a few hours, as the cement would shrink in bulk when drying, and some more had to be added in due time in order to fill the box, which, of course, was done. The lid was then nailed on and results anxiously awaited.

By the next day at about 8 P. M. Punta Arenas was reached, and our cement repairs, which had been thoroughly dried by that time, were given a test. The line was handled very gingerly at first. However, this was soon overcome and in about one hour the pipe had full load upon it and continued so for several days, never once showing signs of weakness or leakage. "Let well enough alone" was the motto then, and on the return voyage a few months later, when again in the cold climate it was still tight.

The ship stopped at Buenos Ayres, Pernambuco, Newport News and New York before a shop job was made of the pipe. On removal of the cement the sheet packing was still intact, and it was so solid that the engineer stated that it would have held out at least a year more before they would expect any weakening.

Referring again to the material of which the pipe was made, in those days a decidedly poor grade of iron was used. Most modern ships do not use iron pipe where it must be exposed to the elements. Copper is used instead, therefore an accident of like nature is much rarer now than then. Nevertheless, the material and principle used in connection with this repair would no doubt serve admirably in several other localities where steam pipes are confined.

F. J. W.

The steamer *Answald,* recently built by the Bremer Vulcan at Vegersack for the Hamburg-Bremen Africa Line, is said to be the first German ocean steamship to be fitted with a superheater. The *Answald* is a boat of 7,800 tons, with a designed speed of 12 knots. Schmidt superheaters are fitted. On her trial trip the engines indicated 3,650 horsepower, giving a speed of 13.5 knots.

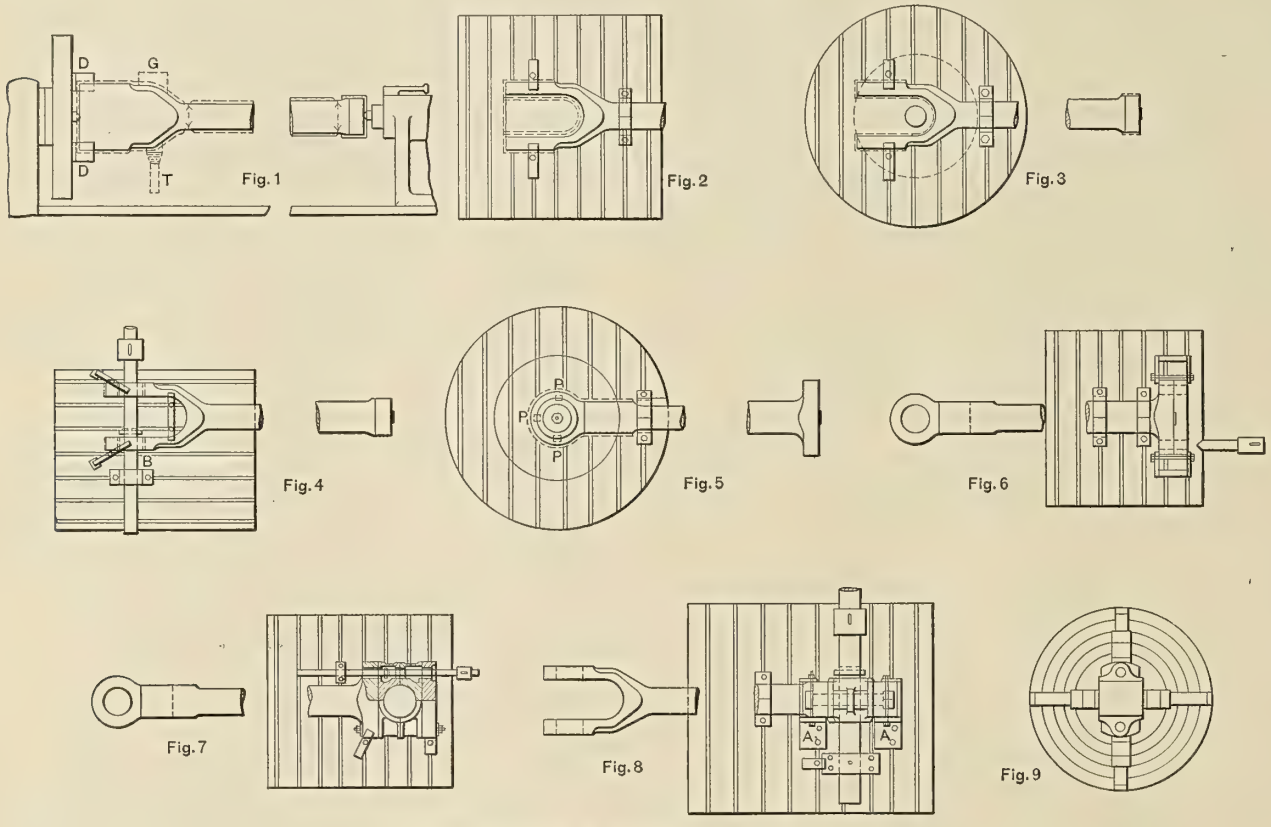
Machining a Connecting Rod.

The first operation is to test the rod on a surface table to see if the forging will machine to drawing sizes, and at the same time to locate the centers of the rod for turning. When the rod is set up on the table in the position shown in Fig. 1, the average center line of the forging is found by measurement and a line drawn on each end. After this, the rod is rotated one quarter turn, and, after squaring up and finding the average center, lines are drawn on the ends of the rod crossing the other lines at right angles; the intersection of the two lines is the center on which the rod will be turned. A light punch mark is made at this point, and two concentric circles are drawn on each end and dabbed in; these are to serve as a guide to the turner when centering and drilling his centers.

The procedure in centering is to form centers deep enough to support the weight of the rod by means of a heavy turner's center punch; the rod is then placed in the lathe, as shown in Fig. 1. To ascertain how the metal will average up, the machinist often rotates the rod at this stage; as, should any discrepancy appear, the centers can easily be shifted, as they are not very deep, whereas it would be a much more serious operation to shift the centers after they had been drilled in full size.

The centers are often drilled in the lathe, the rod being supported on suitable packing. When mounted, as shown in Fig. 1, the turning operations can be completed without removing the rod from the centers. Two heavy angle-plate drivers *DD* are attached to the face plate; a stopper is sometimes fixed to prevent the rod springing away from the drivers when machining the butt and head of the rod; thus preventing the jamming of the lathe and gearing, which would otherwise occur.

The butt is first roughed up to within about 1/32 inch of finish size, the fillet also being roughed down to this size. The parallel part of the head is now roughed down to within 1/32 inch of finish size, the fillet also being roughed down. A cut is now taken over the sloping portion to remove some of the surplus metal, and the fillet on the rod roughed to within 1/32 inch of size. The lathe rest is now moved round to the correct angle for turning the sloping part of the head, and, working from the body of the rod, it is roughed down and scraped; the fillet on the rod may also be finished at this time. After moving back the slide rest, the parallel part of the head is scraped to size. Rounding off the sharp corner on the head to the correct radius is the next step; a gage *G* being used, located in the proper position relative to the parallel and tapered parts. A formed spring-tool T is used to produce a smooth finish.



VARIOUS OPERATIONS IN MACHINING A CONNECTING ROD.

Finishing the foot of the rod is the next step. The tailstock of the lathe is now set over to allow the body to be turned to the proper taper; this finishes the turning operations on the rod. As will be seen from the sketch, the head of the rod is a solid forging. The rod is now taken to the surface table and lined off for machining the sides of the jaws and the feet of the rod; the jaws are also lined off for machining out the metal between them.

Sawing out the metal is the next step. This operation is shown in Fig. 2, where the rod is shown bolted on to the table of a bandsaw. Enough metal is left to allow the jaws to be finished to size in a slotting machine. The rod is now placed on the slotting machine, Fig. 3, and the inside and bottom of the fork machined to size. The outside faces are also machined at this setting. Machining the sides of the rod foot may also be done on the slotting machine.

Boring out the jaws for the crosshead pin is the next step. In Fig. 4 the rod is shown on the table of the horizontal boring machine. The holes are first roughed out as much as possible with drills, then a long cutter bar is passed through both holes, being supported by the bearing *B*. The remainder of the metal is roughed out and the hole finished to size with this bar.

To slot the edges of the jaws the rod is mounted on the slotting machine table, Fig. 5. To locate the hole central with the table a turned disk is used, having a projection on the underside, which fits into the hole in the center of the table, and also one on top fitting the hole in the rod. A heavy stud is sometimes fitted into this disk, and serves to clamp the rod in place, packing pieces, *P*, being fitted between the jaws to prevent springing.

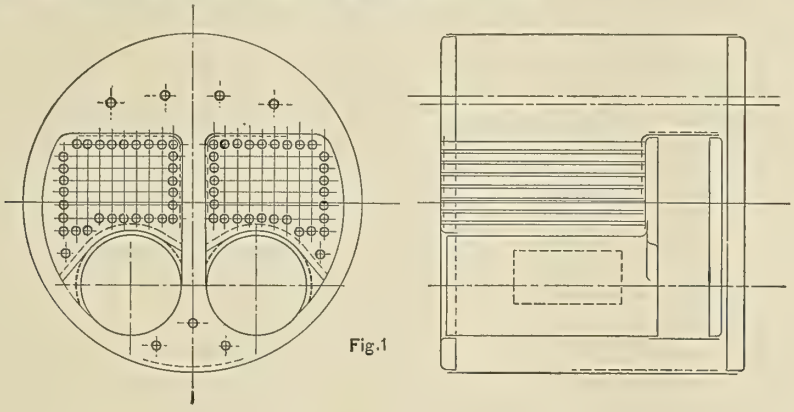
Facing the bottom end bushes and cover may be done very conveniently in the lathe, or boring mill, especially as a recess has to be formed on the top of the upper brass to fit the projection on the rod. In Fig. 9 one of the bushes is shown fixed in the chuck for machining the joint face. The edges of the cover may be either planed or milled, and if a suitable machine is available, both edges may be machined at the same time. Also, instead of slotting the outside of the jaws and the foot of the rod, if a suitable face mill of the planer type, with a cutting head on each upright, is available it should be used, as the outside of each jaw and both sides of the foot may be machined at the same time; or the inside of the jaws may also be milled if there is a machine to take in the rod and a sufficiently long cutter. As the circular part at the bottom of the fork is only for clearance, it will answer equally well if it is touched up lightly with the cutter, and need not be a true half circle. If this is done, the outside of the jaws and feet may be machined at one setting.

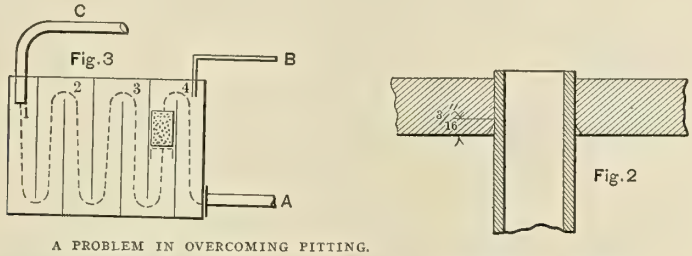
The next step is to bore out the bolt holes in the cover and foot of the connecting rod; they should not be bored out full size, a little metal being left for a cut and a scrape. This operation is shown in Fig. 6, the cover being clamped in position against the rod and the holes bored through both; the holes having been previously marked off on the cover. After this operation the bushes are set up exactly in position and held in place by means of a temporary bolt passing through one of the holes, and by suitable clamps on the other side. The bolt holes in the brasses are usually coned out. A cutter bar is now placed in position and the holes bored out to size. Fig. 7 shows this operation. The cover is also recessed for the nuts, and the foot of the rod faced up for the heads of the bolts at this stage.

The next operation is turning the nuts and bolts. The nuts are bored and threaded to gage, then the bolts which have previously been turned to fit the holes are threaded and finished. They are then fitted into place and the bush is ready to be bored out for the crank pin; a circle first being lined off for the correct position.

In Fig. 8 the rod is shown fixed in position on the table, with the cutter bar in place; the rod being clamped against two angle plates *AA*. It is bored out and faced up to size. The crosshead pin may now be turned. A square is sometimes forged on one end in order that the pin may be turned without reversing on the lathe centers. It is turned a shrink fit for the holes. The lubricator holes may also be drilled at this stage, as, should the drills chance to break, they can be much more easily removed. The holes for the pinching pins in the covers may also be drilled and tapped. The holes for the crosshead pin may be heated by suitable Bunsen burners and the pin shrunk in. Boring and tapping the hole for the small locking pin, then fitting it in, finishes the machine work on the rod.

Machinist.





A PROBLEM IN OVERCOMING PITTING.

Pitting of Boilers.

In a former issue something has been said about boiler corrosion and its causes. The writer wishes to call attention again to the fact that the pitting of a boiler is one of the most troublesome mishaps an engineer may meet, as it generally will not stop entirely, even after all remedies have been tried.

The main causes of pitting are: air, sea water, oil and grease, pumped into the boiler with the feed water, and galvanic action. Sometimes rather strong acids are found in the boiling water. In one case known to the writer, the boiler water was taken in near a chemical factory, where strong waste acids were discharged into the river.

As a general rule the feed pumps of marine engines are much too large for their work, and it is a common rule to have the volume of the pump from two to three times the quantity of the condensed steam. But if the pump is too large, with every stroke a large quantity of air will be pumped into the boiler and the oxygen of this may attack the boiler plates. Where Weir's pumps are in use in connection with a Weir feed heater, it is not possible that any air may be discharged into the boiler by them, as the pumps stop if there is no feed water in the feed heater. But often boilers are found which show no pitting at all, even after several years' running, and without any means provided to keep the air out of the feed water.

The oil, which is used for lubrication of the cylinders, slide valve, piston rods and valve spindles, also finds its way into the boiler with the feed water, and with the high steam pressures and temperatures at which modern marine engines are worked, the oil is split up in the boiler and thereby fatty acids are formed, which may do much harm to the boiler plates. Therefore it is necessary to give to the engines and the rods as little oil as possible.

Sea water contains acids by which pitting may be caused, But with a new, clean boiler, it is strongly advised to feed salt water into the boiler during a short time to get a thin coating of scale on the inside of the plates, as this acts as a protection from the influence of the oxygen and acids which the boiler water may contain. The writer knows a large transatlantic tug company which always fills its new boilers with fresh water, and then keeps the boat moored for 24 hours, the engine running half speed, and the boiler using sea water for feeding. Thus the thin coating is formed, so that there is no danger of pitting, nor of the bulging of the flat plates and the crowns of the furnace. Especially is this danger prevalent in new boilers, as on the trial trips plenty of oil is always given to the engine, which subsequently may lodge on a plate in the boiler, so that it is overheated there and may bulge.

Galvanic action may also often cause pitting, and the only means to counteract its action is to place zinc slabs in the boiler. Such an action is only possible when the boiler water is an acid solution. Steel, with zinc in an acid, becomes electro-negative; the zinc, positive. At the zinc pole oxygen is liberated, which oxides the zinc. At the steel pole, hydrogen is liberated, which, with the oxygen dissolved in the water, forms water again. The zinc thus attracts the oxygen from the boiler plates, but the zinc and steel must be in perfect metallic contact.

A further cause of pitting is formed by the very small copper particles which are taken up in the feed water and pumped with it into the boiler. These particles come from the internal feed and scum pipes, the condenser tubes, the pump lines and the feed-pump valves, and from the copper, salts are formed in the boiler, which may attack the plates. Therefore it is recommended never to use copper internal pipes. Mr. Y. MacFarlane Gray (N. A. 1861, Vol. ii., p. 157) has detected copper specks at the bottom of pit holes, and attributed pitting to that cause. The condenser tubes are usually tinned outside, so that no copper particles can be taken from them by the feed water. But the tin particles may now be carried over to the boiler by the water, and it is believed that the corroding influence of these is even stronger than that of the copper particles.

The boiler of the government coast steamer *S* showed pitting after one and a half years' service. It was thought by the engineer that perhaps too much salt water had been supplied, and therefore more care was taken to fill the tanks up entirely with fresh water, which was taken in on a river at some distance in the country. But after six months the boiler was opened again, and the pitting showed itself such that some means had to be supplied. In Fig. 1 the dotted lines show where the pitting occurred, viz., on the top plates of the fireboxes; on the bottom of the shell, and on the tube plates where the iron tubes were expanded in them. Also around the fusible plugs on the top plates the corrosion was very severe. How the tube plates corroded is indicated in Fig. 2. Nearly around all tubes along the inside of the tube nests corrosion took place, but within the nests no corrosion at all could be detected. Along the path of circulation it seems to be most severe.

The boiler makers were asked how to stop the pitting, and they recommended first, to keep oil and air out of the boiler as much as possible. Therefore a tank was made as indicated in Fig. 3. *C* is a pipe from the hot well, and the condensed steam at the engine is pumped by the air pump into the tank. Therein the water is led up and down, the oil in the meantime being mostly separated from the water. In compartment 4 a case with fine coke was placed, with a perforated bottom. Much oil was found floating on the water in compartment 1; less in compartments 2 and 3, and in compartment 4 scarcely any oil was visible. *A* is the feed-pump suction, thus much oil, which was formerly pumped into the boiler, was now left in the feed tank. In the delivery-valve case of the feed pump a cock was placed, and a pipe *B* led from this cock to compartment 4 of the tank. When feeding, this cock was opened, thus a part of the feed water pumped back to the tank, so that the bottom of this was always covered with water, and no air could be taken in by the feed pumps. By regulating this cock, compartment 4 of the tank could be kept half filled.

So most of the oil and the air were kept out of the boiler. The pit holes were filled up with common Portland cement, as corroded places are most sensible. After two months the boiler was inspected again, but the oil and air apparently were not the causes, for the pitting was still rather dangerous, and it was evident that a new boiler would be necessary, unless the pitting could be stopped. The furnaces were also pitted on both sides, as indicated in Fig. 1. The cement in the pit holes did not hold, and was all washed away. It was then thought advisable to use more soda than the engineer had applied till that time, also to supply a little salt water for boiler feeding. The pit holes were now filled with a mixture of crown tar and red lead.

As the engineer had strong objections against the use of salt water, he tried the former means. After two months the boiler was opened and the interior found in good condition. The boiler plates were all covered with a very thin coating; the pit holes were still covered with the mixture, and no black strips indicating the pitting places could be detected. The boiler was therefore saved, and it was expected that a large quantity of soda would be taken on board. But this was not done, for the chief of the service for which the boat had been built could not believe that the use of the cheap soda would be a sure cure against the costly pitting. He thought a box containing a certain boiler compound worth $12.00 (£2/10) would do much better. So the boiler was treated with the compound. But after another two months the boiler again showed the dangerous pitting. The mixture in the pit holes had protected them against further pitting, but very many new holes had been formed.

Perhaps the manner in which the compound had been applied was not correct, but in this boiler, with this engineer, it could not protect the boiler plates. The boiler has been in use a long time now, using a generous supply of soda, and the pitting has stopped entirely. D. K.

How to Measure the Pitch of a Propeller.

Many people have often wished that the pitch of a propeller could be measured directly without interpolation of any kind. As a matter of fact, this can be done, and easily. It is self-evident that where the blade forms a pitch angle of 45 degrees, the circumference is equal to the pitch, because the distance around the circle is equal to the advance. Therefore, if a 45-degree triangle be placed on the blade at right angles, and moved along until the edge perpendicular to the shaft is parallel to the face of the hub, as can be seen by sighting over the triangle at the hub, the point where the triangle rests on the blade will be the radius of the circumference that is equal to the pitch. Therefore, if the pitch is wanted in inches, take a scale long enough for the largest radius wanted, say 60 inches, and multiply the 60 first by 2 for diameter, then by 3.1416 for circumference. The result is 376.992. Divide the

60-inch scale rod into 376.992, or, say, 374 equal parts. Each part will be roughly 1/6 of an inch. Now, place the triangle by sighting across the hub, and sliding the triangle until its side is parallel with the hub. Measure the radius to the triangle with the scale, and the result is the pitch directly.

Another way is to measure the radius with an ordinary rule, and multiply the result by 6.141, which is the pitch. Of course this method only gives the average pitch, and other methods must be used when the pitch of all parts of the blades are wanted; but where the blades are of commercially uniform pitch, this is a very accurate method of measuring them.

All modern wheels of any efficiency have a point where the angle is 45 degrees. The best authorities call for it to be near the center of effort, but it is to be found on all parts of the blades. On blades with high revolutions and slow speed, it is near the hub, or may even disappear at the hub. On blades with low revolutions and high speed (a very rare condition) it is near the tip.

E. N. Percy.

A Sudden Stop at Sea.

As the editor appears to be getting the practical men among his readers to come forward and relate their seagoing experiences, the following anecdote may be of sufficient interest to be classed among the list of breakdowns:

At 3 o'clock in the morning the chief engineer of a boat that need not necessarily be named came down in a hurry and routed out his staff second. On tumbling out he found, to his surprise, that the engines had stopped, and he could hear the boilers blowing off. There was evidently something wrong, and the two engineers raced down to the engine room together. The third engineer, who was on watch, was in a state of surprise. He said that the engines had suddenly pulled up, and he could not account for it. After they had stopped he had shut the steam off at the engine stop valve pending further investigation.

With a habit born of experience the second went to see for himself that the stop valve was properly shut, and to do so eased it, or opened it a little to shut it again. On easing the valve the engine, to the surprise of everybody, started to go a little. The chief gave orders to keep her going very slowly while he went up to the cylinder top to see if he could detect any unusual noises in the high-pressure slide-valve chest. This was the part of the engine that was, first of all, suspected by everybody. The chief had, however, hardly reached the top platform before the second felt a sharp knock on the stop-valve handle, and it at once dawned on him what the trouble was. The valve closed upwards, and evidently the valve seat had become loose. When the valve was open the seat had suddenly come down onto the valve and had chopped off the supply of steam to the engines, shutting them down.

The steam was then shut off from the boilers, and the faulty stop-valve chest opened. As was anticipated, the seat was loose, and it was taken out to repair the fault. This was done by wrapping it round and round with very fine copper wire. This had the effect of increasing the diameter of the part of the valve seat which fitted into the valve-seat chamber. When this was done, the wire binding was smeared over with manganesite plaster, and over this coarse emery powder was sprinkled. The valve seat was then put into place and driven hard up into position, and then the remaining parts were assembled. It was then possible to start the engines away, and after this experience the valve never gave any more trouble.

It is probable that the primary cause of the loosening of the valve seat was the rattling of the wings of the valve against the sides of the valve seat. In order to guard against trouble of this nature the valve seat would have been more secure if it had been fixed in position by means of small tap bolts. The incident is, however, sufficiently interesting, perhaps, to merit the attention of other marine engineers.

Joe Brown.

Two Sea-Going Repair Hints.

Sea-going engineers are often called upon to effect running repairs, which their friends on land would consider almost impossible, considering the very limited range of tools and equipment available on board ship. Many of the repairs thus effected can only be regarded as make-shift devices adopted to hold the trouble in its place until the ship reaches a port where more adequate facilities are at hand. At the same time it is perhaps to the credit of the marine engineer that he is in so many cases able to avoid immediate trouble by the exercise of a little ingenuity.

For example, one of the troubles to which a marine engineer is subject is the occurrence of leakage in his condenser tubes. This is first detected by the rapid filling of the boilers, or by observations of the density of the water in the boilers. If the density increases above its average, then it is easy to believe that there is a leakage of salt water from the condenser to the hot well, and this must be attended to as quickly as possible.

In order to find the leak it is necessary to take off the condenser doors and the manhole door, and fill the condenser full of water. By examination it can be readily seen which tubes are leaking, as the water will be observed running out of them. When they are found, wooden blocks should be made to fit the tube and driven in at both ends of the tube so that they are a tight fit, thus isolating that section from further action. This, of course, brings down the efficiency of the condenser until the ship is brought back to port, but it saves further trouble with the boilers, and the device answers very well for a temporary repair.

Another instance may be cited in the case of a fracture of an eccentric strap. This cracked right across, and of course threw the whole of the engine out of smooth running. It was necessary to shut down as quickly as possible, and to straighten the eccentric rod. In order to patch up the strap sufficiently well to carry the boat through to the end of her voyage, a piece of bar iron about ⅜ inch thick and 2½ inches broad was shaped to the outline of the top half of the strap. It was then bolted in its place by two bolts. On top it was held down by the weight of the eccentric rod. This repair bound together the two pieces which were cracked until the end of the voyage and prevented further trouble.

Edward S. Reid.

Full Speed Trial of Brazilian Destroyer.

The official full-speed trial of the torpedo boat destroyer *Santa Catharina,* built for the Brazilian government by Messrs. Yarrow & Co., Ltd., of Glasgow, took place Feb. 2 on the Skelmorlie deep-water measured mile at the mouth of the Clyde. During a continuous run of 3 hours, carrying a load of 100 tons, the boat exceeded her contract speed of 27 knots.

The *Santa Catharina* is the eighth of the ten destroyers ordered by the Brazilian government from Messrs. Yarrow. The first six vessels are now in commission in Brazil. The seventh will be leaving Glasgow shortly, and the ninth and tenth vessels are ready for launching. In these destroyers strength of construction and good seagoing qualities were deemed—as in the British navy—of even greater importance than high speed, as both the British and Brazilian destroyers have a guaranteed speed of 27 knots.

The dimensions of the Brazilian destroyers are: Length, 240 feet; beam, 23 feet 6 inches. They are propelled by two sets of four-cylinder reciprocating engines of 8,000-horsepower. Steam is supplied by two Yarrow boilers.

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The Economy of Superheated Steam.

Reliable data, giving an exact comparison of the performance of a marine steam engine when using saturated and when using superheated steam, are not very plentiful, and, consequently, the very complete and accurate tests which were made on the steam yacht *Idalia* to determine the economy of using superheated steam, the results of which are published elsewhere in this issue, deserve careful consideration. We have pointed out in previous issues that the steam consumption of a marine turbine can be reduced approximately one percent for each 10 degrees Fahrenheit of superheat, and that nearly as good results can be expected with reciprocating engines. The tests on the *Idalia* bear out these conclusions remarkably well, for they indicate that a net gain of 10 percent in heat consumption may be obtained by superheating 100 degrees Fahrenheit, or that a saving of coal of one percent may be expected for each 10 degrees Fahrenheit of superheat. It is also pointed out that in cases where there are relatively large losses from condensation, as when running at low powers, the gain due to the use of superheat will be even higher. A gain of 12 percent in economy might confidently be expected in such cases with 100 degrees superheat.

Although the adoption of superheated steam for marine work has not been rapid, and many engineers have considered that the somewhat vague claims made for its advantages could not be realized in actual practice, yet in view of the results which have been achieved in recent years, it is evident that its claims can no longer be overlooked where economy in the operation of the marine steam engine is to be considered. The mechanical difficulties encountered in early installations have apparently been overcome, and in this connection it is interesting to note that the problem of lubrication was successfully solved on board the *Idalia* by the use of fine graphite mixed with water in the steam cylinders of both the main and auxiliary engines.

Shallow Draft River Steamers.

From recent developments in Congress it is probable that the people of the United States will soon be committed to the expenditure of enormous sums of money for the improvement of their inland waterways and navigable rivers to encourage transportation by water. The greater part of these expenditures will be for the widening and deepening of channels in the rivers and the maintenance of these channels at a uniform depth. Whether such enormous expenditures for this purpose will bring any adequate return on the investment or not is very problematical, since the development of river transportation does not depend alone upon the improvement of the waterways themselves. Just as important, and perhaps more so, are the development of landing and docking facilities and the establishment of warehouses and freight-handling appliances by the cities which form the terminals for this traffic. There are over 20,000 miles of navigable rivers in the United States, much of which has in the past been utilized for river transportation, with little or no improvement of the waterways themselves. On the Western rivers, in particular, up to 1864 there was a wonderful growth in river traffic; but since then this business, except for the transportation of coal, has steadily declined. The decline has been due, of course, to the competition of the railroads, and it was only during the period from 1845 to 1870, while the railroads were in the process of development, that river transportation attained its supremacy. However, as long as there was a demand for river transportation, fast passenger and freight boats and powerful towboats were designed and built which successfully met the existing conditions in the rivers, and transportation was carried on with little or no improvement in the waterways themselves.

In view of these facts, it seems as though the most logical way in which to upbuild the river transportation to-day is to improve the terminal facilities and

the type of carrier, and to maintain a clear channel in the waterways at approximately the depth which naturally exists, rather than to spend large sums of money in constructing deep channels to accommodate vessels of considerable draft. That the amount of freight which is likely to be transported by river can be carried on a shallow draft just as well as on a deep draft is generally conceded by river men and boat men. Millions of tons of freight are carried every year on navigable European rivers, where the depth of water is very much less than exists to-day in many of the large rivers in the United States. The average depth of the Rhine is 6 feet, and of the Elbe only 4½ feet; and yet millions of tons of freight are transported annually over these rivers. The average depth of the Mississippi from St. Louis to New Orleans is about 9 feet, and the average depth of its entire length is 6 feet; and yet it is maintained that this should be increased to 14 feet, in order to adequately develop its transportation facilities.

In connection with the improvement of waterways the Government proposes to carry out investigations to determine the best type of boat to be used for river practice. The stern-wheel steamer has long been pre-eminent for this work, and it is a type of boat which has been evolved by practical men to meet what are probably the most difficult requirements which any boat has to fulfill. The boat being pivotal about the wheel as a center, a uniform depth of immersion is always insured for the paddles, no matter how heavily the boat is loaded. Moreover, the maneuvering and backing qualities of the boats are exceptionally good, and these are requirements which are essential in river practice, where shifting channels, varying depths of water and lack of proper docking facilities frequently necessitate backing off from the banks or sand bars, etc. Although the main features in the design of stern-wheel river steamers are excellent, there is considerable room for improvement from an engineering point of view in the design of the main propelling machinery, and in this connection it is instructive to note some of the features of German river steamers.

The type of river boat used in Germany differs from the American river boat chiefly in the matter of engines and propellers. American river steamboats are the product of practical evolution rather than of scientific engineering design and, while they accomplish their work in a highly satisfactory manner from a practical standpoint, their engines show poor economy and leave room for considerable improvement. In German river steamers, on the other hand, the features which have proved so successful in American river boats have been adopted; but their engines and propellers have been designed with a view to good economy. The immense wooden paddle-wheels of the American boat, some of which are 30 or 40 feet in diameter and 30 or 40 feet wide, weighing as much as 160 tons, fitted with a large number of radial wooden buckets, are replaced on German boats by two steel feathering paddle-wheels of, perhaps, 12 or 13 feet diameter and 8 feet wide, with, at the most, seven buckets to a wheel, operating at a higher number of revolutions than the large, heavy wheels on American boats. The main engines of American steamboats are either simple or compound, long-stroke lever, poppet valve engines, using steam at high pressures and exhausting it also at high pressures, and, consequently, wasting a considerable portion of the available energy in the steam. As a rule, simple, non-condensing engines are favored, since compound condensing engines, although they cut down the fuel consumption, add so much in weight and take up so much space that they are usually not considered a profitable investment. The main engines of German river boats are usually either compound or triple-expansion condensing engines (depending upon the steam pressure used) of efficient design and moderate weight. The horsepower runs from about 500 to 750 in the smaller boats on the Elbe and Oder and up to 1,000 and 1,500 horsepower in the large boats on the Rhine. Records of fuel consumption show that these boats operate with an average coal consumption of only about 1¾ to 2 pounds of coal per indicated horsepower per hour for all purposes.

Tunnel boats, driven by screw propellers, have been tried to a certain extent for river work and have proved successful. The use of water-tube boilers, multiple-expansion engines and screw propellers makes at once a very large reduction in the weight of propelling machinery. In one case the relative weights of paddle-wheels and high-speed screw propellers were found to be 140 tons and 4½ tons. The weight of paddle-wheels on American river boats could, however, be considerably reduced if two steel feathering wheels of small diameter were used in place of the single large radial wheel now employed.

Marine Auxiliaries.

We are publishing this month a résumé of the development of auxiliary machinery on board ship and descriptions of many of the modern appliances which play such an important part in the economical operation of an up-to-date marine power plant. Of course, it is impossible to go into very much detail on such a varied and complex subject as this in a single article; but it is possible to mention the more important features and point out their relation to the plant as a whole. No auxiliary machinery has ever gained a firm foothold in the marine field until it has demonstrated that it is worth the extra cost and weight and space and added complication which it entails, and for this reason some of the refinements met in shore practice do not exist in marine work. In general, however, marine engine-room auxiliaries have been developed to a high degree of efficiency.

Progress of Naval Vessels.

The Bureau of Construction and Repair, Navy Department, reports the following percentages of completion of vessels for the United States navy:

	Tons.	Knots.		Jan. 1.	Feb. 1.
BATTLESHIPS.					
Delaware ...	20,000	21	Newp't News Shipbuilding Co.	98.5	99.5
North Dakota	20,000	21	Fore River Shipbuilding Co..	98.0	98.6
Florida	20,000	20¾	Navy Yaard, New York.....	46.4	50.5
Utah	20,000	20¾	New York Shipbuilding Co..	58.2	62.2
Arkansas ...	26,000	20½	New York Shipbuilding Co..	8.0	11.8
Wyoming ..	26,000	20½	Wm. Cramp & Sons.....	6.0	9.0
TORPEDO-BOAT DESTROYERS.					
Lamson	700	28	Wm. Cramp & Sons.....	98.1	100.0
Paulding ...	742	29½	Bath Iron Works.....	59.8	64.6
Drayton	742	29½	Bath Iron Works.....	54.3	59.9
Roe	742	29½	Newp't News Shipbuilding Co.	70.8	73.0
Terry	742	29½	Newp't News Shipbuilding Co.	70.7	72.1
Perkins	742	29½	Fore River Shipbuilding Co..	64.8	65.3
Sterrett	742	29½	Fore River Shipbuilding Co..	64.4	65.0
McCall	742	29½	New York Shipbuilding Co..	42.1	48.1
Burrows	742	29½	New York Shipbuilding Co..	42.1	48.1
Warrington..	742	29½	Wm. Cramp & Sons.....	58.0	60.3
Mayrant	742	29½	Wm. Cramp & Sons.....	58.8	60.9
Monaghan ..	...	..	Newp't News Shipbuilding Co.	7.4	10.1
Trippe	...	..	Bath Iron Works.....	13.5	18.4
Walke	...	..	Fore River Shipbuilding Co..	9.9	11.9
Ammen	...	..	Fore River Shipbuilding Co..	10.9	12.4
Patterson ...	...	..	Wm. Cramp & Sons.....	6.7	9.1
SUBMARINE TORPEDO BOATS.					
Salmon	...	..	Fore River Shipbuilding Co..	90.4	90.6
Seal	...	..	Newp't News Shipbuilding Co.	34.1	36.6
Carp	...	..	Union Iron Works.....	35.6	39.1
Barracuda ..	...	..	Union Iron Works.....	35.3	39.1
Pickerel	...	..	The Moran Co.....	32.0	36.9
Skate	...	..	The Moran Co.....	32.0	36.9
Skipjack	...	..	Fore River Shipbuilding Co..	13.6	16.8
Sturgeon ...	...	..	Fore River Shipbuilding Co..	13.5	16.6
Tuna	...	..	Newp't News Shipbuilding Co.	12.3	14.0

ENGINEERING SPECIALTIES.

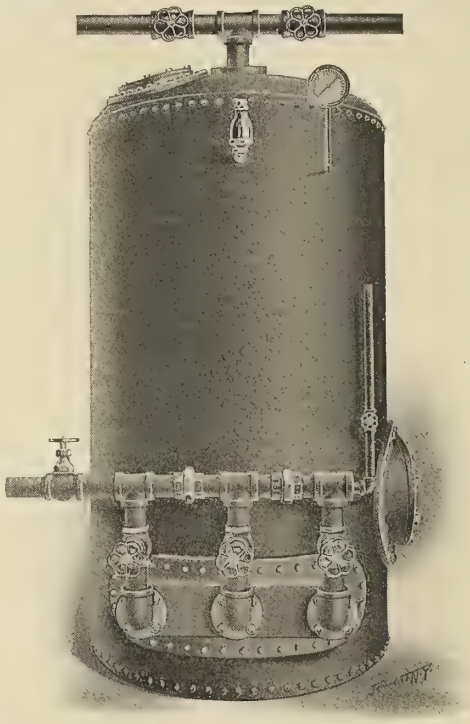
Krause-Miller Absorbent Condensation Filters.

Steamboat owners and marine engineers generally will be interested in the results obtained with the Krause-Miller absorbent condensation feed-water filter installed on Dredge *No. 2*, belonging to Walter A. Gahagan, at Far Rockaway, L. I., where some extensive dredging and large reclaiming operations are in progress. The special function of this filter is to remove the last traces of oil or grease from the condensed water, leaving it clear and bright, and thus avoiding the dangers attendant on feeding oil or grease into steam boilers, such as the risk of burning out tubes, bulging furnace plates and possible explosions.

Innumerable attempts have heretofore been made to satisfactorily clarify and totally remove the last traces of grease from condensation, but many of these have succeeded only in removing the coarse or floating oil from the water by means of skimming tanks, sawdust, excelsior, Turkish toweling, and other straining methods. Experience has, however, shown, that it is not sufficient or safe to remove only the coarse oil, and that the milky looking or emulsified oil must also be completely removed in order to render the water perfectly safe for boiler use.

A careful analysis of the condensation from the Ball & Wood engine on Gahagan's dredge, showed that the coarse or floating oil had been entirely removed, but that the milky or emulsified oil, which would readily pass through any of the numerous cloth or other filters, still contained seven parts of oil per 100,000 parts of water, or, in other words, as much as 4.06 grains of oil per gallon. The appearance of this water was cloudy and semi-transparent when viewed through a glass bottle 1½ inches in diameter. As the boilers on the dredge were being fed at the rate of 1,506 gallons per hour, the amount of grease with which they were being charged per day of 11 hours, previous to filtration, amounted to 9.46 pounds, or 1 1/3 gallons. In a month of twenty-six working days, this might therefore easily amount to 34½ gallons. The evil results of such a quantity of oil pumped into a boiler every day can best be appreciated by experienced engineers and needs no further comment, except to say that with even a fraction of the above original amount of oil in the feed water, say only ½ grain per gallon, the amount of oil entering the boiler per month would still be undesirable, if not unsafe.

In the condensation filter now installed on the Gahagan dredge, and which, it is claimed, is delivering the water absolutely free from any traces of oil and perfectly clear, the filtering material used consists of a non-soluble fibre, which has a strong absorbent or physical attraction for oil, retaining within its pores from 20 to 50 percent of oil. There are no chemicals used, nor any expert attendance necessary, and the material lasts a very considerable time without change. In a filter 36 inches diameter by 5 feet in height, made on these principles, which has been in use for seven months in the Miller Brothers shop, and through which have passed in the last six months 3,000,000 pounds of water, they are still getting perfectly clear feed water according to chemical analysis. The expense of its operation during this period has been not over $4, it not having been found necessary in that time to renew the filtering material, the only expense having been the attention of the engineer for 15 minutes every three weeks to reverse the current and free the top of the filter from the accumulated oil.

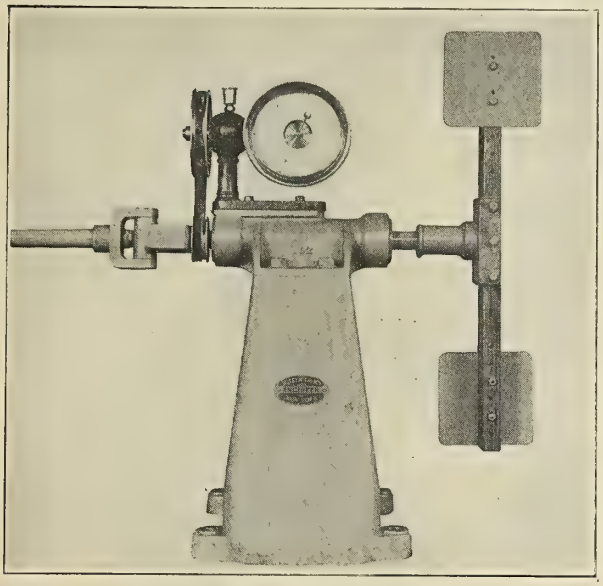


These filters are manufactured by Alex. Miller & Bro., Jersey City, N. J.

A Fan Dynamometer.

The standard type of fan dynamometer illustrated has been placed on the market by Joseph Tracy, consulting automobile engineer, 116 W. Thirty-ninth street, New York. It consists essentially of a metal standard carrying a horizontal steel shaft in large ball bearings; one end of this shaft is connected to the motor under test by a universally jointed extension shaft, the other end carries an overhung two-bladed fan. On the dynanometer shaft a small pulley fitted to a boss on the rear of the universal joint is belted to a larger pulley on the special tachometer, which is mounted on top of the housing that carries the dynamometer shaft.

The tachometer is provided with a double scale and single pointer; the inner scale showing the revolutions per minute, and the outer scale the horsepower developed. The revolutions per minute scale is graduated, progressively, by divisions of 20 revolutions from 200 to 2,000. The horsepower scale gives a minimum reading of 1 horsepower at 480 revolutions, and a maximum of 70 horsepower at 1,980 revolutions. Consequently at all ordinary rates of motor speed a simultaneous



reading of revolutions per minute and horsepower can be obtained without any computation.

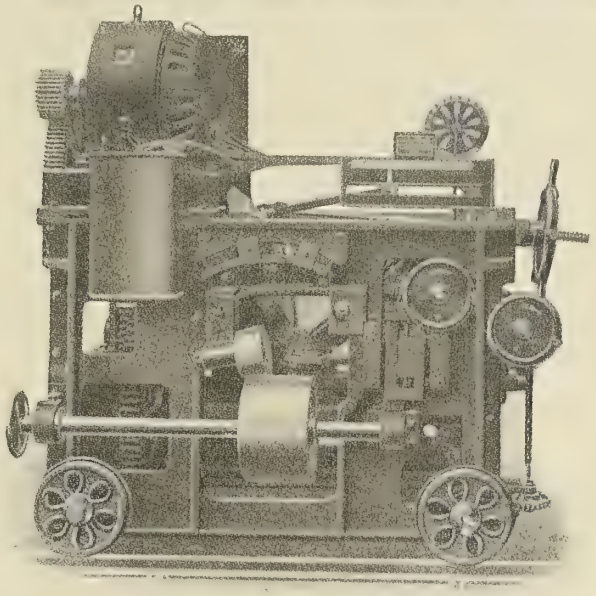
The dynamometer can be employed in testing motors on the block by making suitable connection between the jointed dynamometer shaft and the motor shaft, clutch or flywheel. It can also be used to test an automobile motor in position on the chassis by disconnecting the propeller shaft and substituting for it the jointed shaft of the dynamometer.

The apparatus is designed to test motors of medium size. However, by the use of fan blades of greater or less area, and suitable tachometer scales, the range of absorption and measurement of power can be varied between wide limits.

Davis Beveling Machine.

The common method of beveling bars by hand labor, besides being expensive and unsatisfactory, is also injurious to the material. In beveling a bar, the angle has, in the first instance, to be guessed at by the workman; then altered back or forward, until it conforms with the bevel obtained from the body plan of the ship. It follows that the best heat has gone from the bar before this can be done—and when the bevel is extreme, the bar, before being finished, has to be heated, in some cases, several times; in consequence of which the metal becomes brittle and unsatisfactory, the flanges hollow, and the edges unfair. It is drawn and disfigured by hammering, and the holes in the beveling slabs are imprinted on the outside surface, so that when the work comes to be put together it cannot fay close; and when the riveters attempt to close up the work with the aid of quarter hammers, they often finish by breaking or fracturing it.

The Davis patent beveling machine, manufactured by Davis & Primrose, Etna Iron Works, Leith, has been designed to obviate the foregoing evils. The machine is mounted on rails in front of the furnace, and when needed it is brought up opposite the furnace mouth. It draws the bar out of the furnace and does the beveling when the bar is at its best heat. It is also claimed that it smooths down the rough edges of the rivet holes, so that the rivet head gets close up at neck, and the work fays close; the operation being done by rollers when it is hot, the edges of the bar are fair, and free from local strains. The time occupied by beveling being so short, the bar, when it has left the machine, is sufficiently hot to be turned without reheating. For frames and other work, the bevels are taken from the body plan of the ship at regular intervals along the bar, the spot numbered, as usual, the angle at each number or



spot is measured, and the numbers transferred to the corresponding angles on the bevel board. On the machine is what is termed the bevel index, which is graduated into degrees from 90 to 45 degrees. The angles which have been marked on the bevel board are then indicated by their numbers on the bevel index of the machine, in their relative positions, measuring from the end of the bar. It is claimed that the machine saves about 50 percent of the labor on such work.

Automatic Cut-Off Valve.

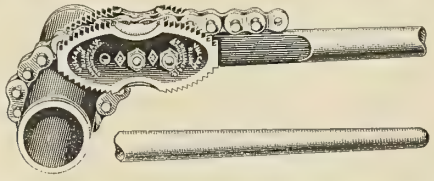
Harmful results, due to escaping steam, from failures in watertube boilers can be successfully prevented by installing an automatic cut-off valve. When one of these valves is installed between each boiler and the steam header, it forms an automatic stop, no matter where the break may occur. The valve illustrated herewith, manufactured by the Lagonda Manufacturing Company, Springfield, Ohio, is of the double-acting type; that is, it works equally well in either direction. Should a single tube in one boiler give way, this valve would instantly isolate that boiler. On the other hand, if a break occurs in the steam main between the boiler and the engine, or, for that matter, in any part of the steam loop, all of the valves instantly close, preventing escape of steam. This valve depends for its action upon the actual flow of steam, and not upon the differences in pressures, and whenever abnormal flow occurs in either direction, it is claimed that the valve instantly shuts. It takes the place of the ordinary stop valve, and can be used as such, but should not be confused with the ordinary single-action, non-return valve. One important feature of the Lagonda valve is, that there are no internal working parts. A dash pot is fitted on the outside to prevent chattering, or the closing of the valve too quickly when sudden overloads occur.

Tests of this valve made in Washington, D. C., before a Board of Supervising Engineers of the Department of Commerce and Labor showed that when an opening was made be-

tween the valve and the boiler, equivalent to an outlet 1 5/16 inches in diameter, the valves closed promptly. To show the action when a break occurs on the other side of the valve, a quick release valve was opened, corresponding to an outlet of 1½ inches in diameter. It is reported that the valve closed in 2 seconds, and the steam pressure was only reduced from 180 to 140 pounds, the rush of steam closing the valve. Other interesting tests were made to prove the reliability of the valve. To test its action under sudden overload a quick-release valve was opened corresponding to an opening of 1½ inches. Thirty seconds was consumed in opening the quick-release valve this time, and the steam pressure dropped from 180 to 90 pounds, but the automatic valve remained open. These tests prove that the valve can take care of any unusual but legitimate demand for steam, and still be sensitive enough to close quickly in case of accidents. By means of the dash pot and weight the valve can be adjusted to suit the local conditions of steam pressure and overload. The board of supervising engineers who witnessed these tests approved its use in all marine service. The valve is built in sizes from 3 to 12 inches. A special "low-down" type is made for use where headroom is limited on board ship.

Vulcan Bijaw Chain Pipe Wrenches.

J. H. Williams & Co., Brooklyn, N. Y., who, since 1884 have been developing chain-pipe wrenches, have just brought out a new wrench known as the "Vulcan Bijaw." This wrench is made with double-ended reversible jaws, which can be readily turned end for end when the tool wears, thus doubling the life of the tool and insuring that it will be always ready for service. Two studs or bolts through the

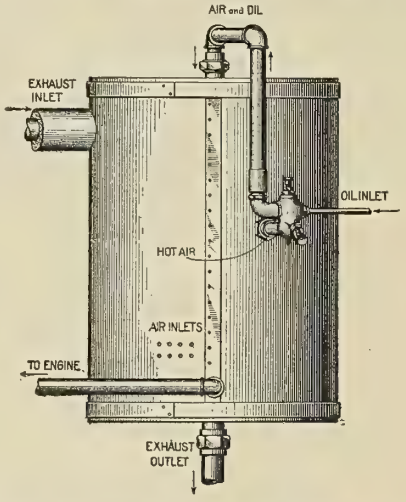


handle prevent the spread of the jaws when in use. The material in these studs is of great strength, and in case of accident repairs may be made on the spot by moving forward the rear stud, since it is claimed that one bolt or stud will still provide working strength for the tool. The application of the jaws to the handle remains the same milled construction which has given satisfaction for so many years in the "Vulcan" wrenches manufactured by this company. These wrenches are made in sizes for ⅛ to 12-inch pipe and fittings, with interchangeable cable or flat-link chains.

The Hydrocarbon Converter.

Recent activities in the marine producer-gas field have been confined entirely to the use of coal as a fuel. A new application of this principle is now being brought out, however, by the Hydrocarbon Converter Company, 37 Wall street, New York, who are placing on the market an apparatus for the gasification of fuel oil. By means of this apparatus, which is called the hydrocarbon converter, it is claimed that the oil is completely gasified and that the gas can be delivered to the engine at high temperature, where, upon mixing with the proper amount of air, the usual explosive mixture is formed. The value of this converter is evident when the comparative cost of different liquid fuels is considered. In New York markets gasoline (petrol) may be quoted at 14 cents (7 pence) per gallon, kerosene (paraffin) 7 cents (3.5 pence) per gallon, and fuel oil 3 cents (1.5 pence) per gallon, while in Europe gasoline (petrol) ranges from 30 cents (1/3) per gallon upward. Not only is the cost of the fuel an advantage but the ease of handling and safety of using fuel oil as compared with other liquid fuels and with solid fuels are important considerations in marine work.

The converter comprises a nest of three cast iron cylinders, one within another, thus making three compartments, an inner, a middle and an outer. The apparatus being suitably installed in connection with the engine, as is a carbureter, the exhaust pipe is connected to the middle compartment through which the hot waste gases circulate and find an outlet through a continuation of the exhaust pipe on the other side, the inner and outer compartments becoming highly heated by radiation from the middle compartment. The inner compartment contains a channeled nest of cylinders of crucible material which is of a minutely porous character. Under the heat communicated from the middle compartment these porous cylinders quickly absorb and retain a high temperature. Air is introduced through orifices into the outer chamber, where it also is highly heated, and then passes out through a pipe which unites with



a pipe from the oil supply tank, and there is then drawn through them into the inner compartment by the suction of the engine, a mingled stream of oil and air. In passing through the channels of the hot porous cylinders in the inner compartment, the oil is gasified, the final product being an airified hydrocarbon gas of high temperature, which is delivered to the engine by a pipe passing from the center of the inner compartment. The heat of the inner compartment is supplemented by slow and more or less incomplete combustion of some of the constituents of the oil and the oxygen of the air, resulting principally in formation of carbon monoxide, and which maintains a considerably higher temperature in the porous cylinders than that of the engine exhaust gases.

The converter contains no moving parts, and does not require the use in connection with it of a fan or blower, such as is commonly used with coal gas producers or in such special types of engines where the fuel is fed under high compression. The suction of the engine is the controlling power that automatically regulates the flow of oil and air into the converter and the gas from it; when once started in operation practically no attendance is required. The engine can be started either on gasoline or by a preliminary heating of the converter by means of a torch.

The complete gasification of any oil is apparently dependent upon a division of its mass into most minute fractions and subsequent submission in that state to a high temperature. Methods heretofore in use for the breaking up of the oil have been mechanical, and such as to produce a spray or liquid vapor or mist, each globule of which upon exposure to the required heat undergoes chemical transformation, but unless the heat penetrates to the center of the globule, so that its action is uniformly effective throughout, such transformation is not complete, only the more volatile contents gasifying and

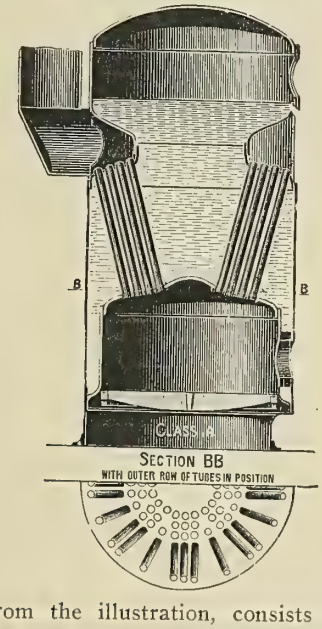
the heavier carbon compounds remaining unchanged. It is claimed that the hot porous cylinders of the hydrocarbon converter absorb the oil, and within their pores it is so divided and sub-divided into microscopic particles that it may nearly approach a true molecular distribution, and in such an extremely fine state of division, and with each minute particle surrounded by the hot walls of the pore cell, the applied heat penetrates so evenly and effectively that the chemical transformation of each particle to gas is complete.

The apparatus has been installed for several months upon a 78-foot yacht driven by a 70-horsepower Twentieth Century engine. Comparative tests on this yacht, using first gasoline (petrol) as a fuel and then gasified fuel oil, resulted in the use of 12.125 gallons of gasoline (petrol) per hour, costing $1.697 (7/1), and only 5 gallons of crude oil per hour, costing $0.15 (7.5 pence) for the same service. An analysis of a sample of the gas taken from the converter showed the following percentages of constituents: CO_2, 7.6; O, 1.2; illuminants, 9.4; CO, 3.1; H, 1.9; CH_4, 7.5; N, 69.3; calorific value of the gas, 286 British thermal units. The gas is delivered to the engine at a temperature ranging from 600 to 1,200 degrees F., and a compression of about 80 pounds per square inch is used in the engine.

Although the immediate principal application of the hydrocarbon converter will undoubtedly be in connection with the gas engine, yet it has a number of other important applications, for it is claimed that by means of it oil fuel can be successfully fired under steam boilers and in various industrial furnaces, and also that a good illuminating gas can be produced by it.

The Genetic Boiler.

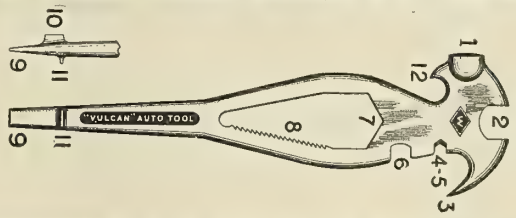
A small vertical multi-tubular boiler, which is used as a donkey boiler on large vessels and as the main boiler for steam yachts, launches and smaller boats, is made by Messrs. T. Toward & Company, at the St. Lawrence Iron Works, Newcastle-on-Tyne. This boiler is known as the Genetic, and, as



can be seen from the illustration, consists of an upright cylindrical shell, 11 feet by 5 feet, with a combustion chamber formed in the bottom of it, from which extend a number of fire tubes arranged in circles, communicating at their upper ends with an annular chamber connected with the chimney by a series of tubes. The effective heating surface is given as 330 square feet, and the boiler is stated to be capable of evaporating 10 pounds of water per pound of coal. The inventor of this boiler claims that its construction is both simple and exceptionally strong, since there are no flat surfaces and no parts which are subject to undue deterioration. It is claimed to be easily accessible for cleaning and repairs, and to have a high evaporative efficiency, besides occupying only a small space.

The Vulcan Auto Tool.

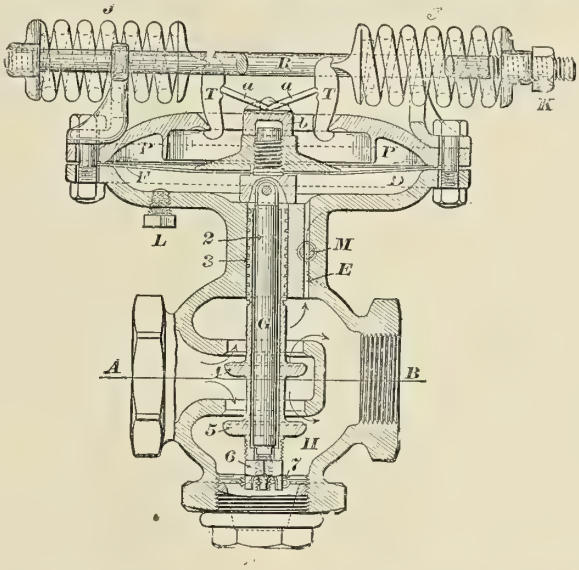
The illustration shows a handy tool for the motorist or motorboat owner, which has just been placed on the market by J. H. Williams Company, Brooklyn, N. Y. The tool has



no moving parts, yet it can be used for the following purposes: hammer, a tire lug wrench, cotton pin puller, gas-tank wrench, wire insulation scraper, air-tank wrench, spark-plug wrench, alligator wrench, cotter pin spreader, three screw drivers and a bottle opener.

Foster Patent Reducing Valve.

The most serious objection to reducing valves using a compression spring is the fact that the power of the spring is never the same under two different degrees of compression, hence it is evident that any change in the position of the valve in relation to its seat causes also a change in the power of the spring; thus such a reducing valve will not open beyond a certain point unless the pressure on the reduced side falls. In order to overcome this difficulty, W. H. Bailey & Company, Ltd., Albion Works, Salford, Manchester, have placed on the market a full-bore pressure reducing valve, which, it is claimed, can open full-bore, if necessary, and yet



prevent the reduced pressure rising above that at which the valve is adjusted, so that if a demand for more steam be made on it it instantly opens wider and supplies that demand but maintains a uniform reduced pressure.

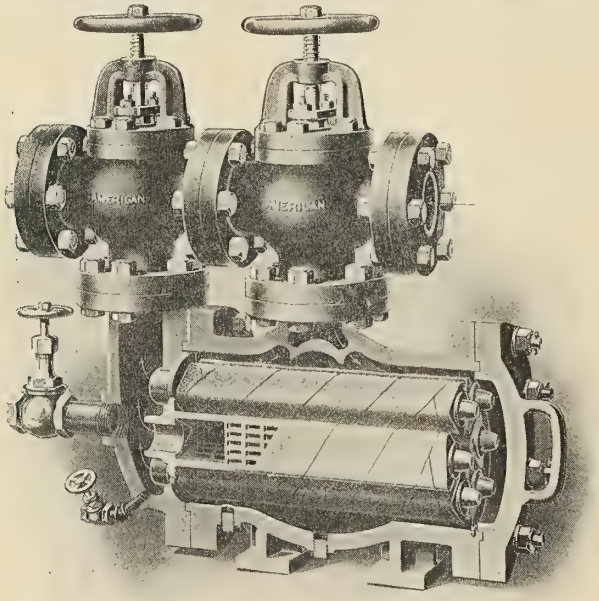
The constant and uniformly-acting power needed to resist the closing of the valve is secured by interposing toggle levers between the diaphragm and spring. The increasing power of the spring, as it is compressed, is compensated for by the increasing power of the toggle levers as they come into line.

This reducing valve is provided with a balanced valve so constructed as not to become distorted under varying condi-

tions of temperature and pressure. The construction of this valve may be briefly described as follows: First, the body of the valve is so made that the inner and outer casings are connected with expansion-resisting webs, which carry off the heat by radiation equally on all sides and thus prevent distortion of the seats. Second, the elongation of the neck between the two clappers is compensated for by making the upper seat almost flat and the lower seat nearly straight (15 degrees off the vertical line). By this means the upper seat is brought to its bearing by the force of the delivery pressure acting on the diaphragm, while the lower seat finds its bearing by diametrical expansion.

The American H_20 Grease Extracting Feed Water Filter.

The illustration shows a grease extracting feed-water filter manufactured by the American Steam Gauge & Valve Manufacturing Company, Boston, Mass. It consists essentially of a number of filtering cages placed radially in a casing, the cages being covered with Turkish toweling (linen Terry),



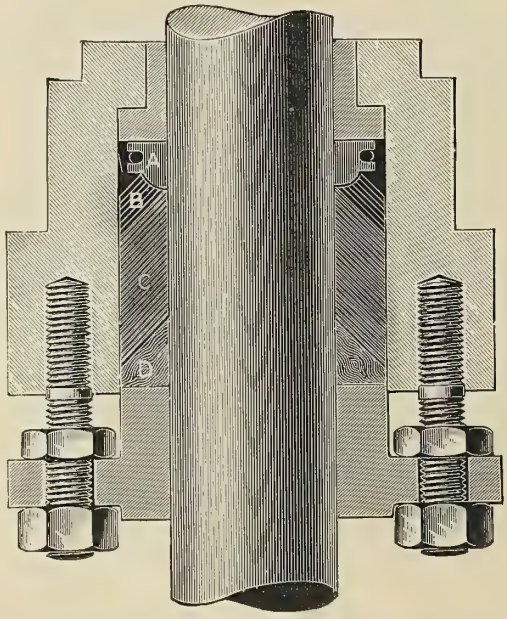
providing an exceptionally large surface through which the feed water passes. The total surface area of the covered cages is 320 times the area of the feed-water pipe, so that the opportunity for clogging is very remote. The filter is simple in construction and admits of easy renewal of the covering for the cages when necessary. The filter is provided with a special attachment for applying a reverse current of steam, by means of which a large proportion of the oil collected may be instantly blown out and drawn off through the drain cock.

The Sentinel Multiple Feed Water Filter.

The "Sentinel" multiple feed-water filter and oil separator, manufactured by Alley & MacLellan, Ltd., of Glasgow, consists of a vertical cylinder carrying a casing at the bottom, which is free to swing about a central vertical shaft. Projecting up from this casing are perforated brass tubes placed radially. Each of these tubes carries a filtering mantle, which is made of cocoanut fiber, a material which it is claimed has a great affinity for oil, and since it is of a porous nature, fourply of fiber can be used around each mantle holder without the risk of chocking the filter. This apparatus provides a filter surface 250 times the area of the feed-water pipe. It is also very convenient for cleaning, since the casing carrying the filtering mantles can be swung about and each mantle removed in its turn through a small opening in the cover.

Christie's Galvanic Metal Packing.

W. Christie & Company, 50 Wellington street, Glasgow, manufacture a metallic packing which consists principally of a series of thin rings of pure galvanic deposits of nickel and copper sewn together in sections of from ¼ to ¾ inch deep. This packing is claimed to be exceptionally good for excluding air from the glands of low-pressure cylinders, or in any place where a packing is needed for low-pressure glands. As the packing is made in conical or funnel shape, it acts automatically under steam pressure, the inner edge being pressed against the piston rod and the outer edge against the



wall of the stuffing-box. Where this packing is used it should be fitted as shown in the cut. First, a white metal cuff in two pieces, held together with a spring, is inserted, and then one or two collar rings *B*, especially cut to go over the body of the cuff. Next, are placed the galvanic metal packing rings, as shown at *C*, the joints being varied about one-third of the circumference in their relative positions. Finally, after the stuffing-box has been packed full, a closing ring *D* of asbestos is inserted, in order to preserve the packing at its correct angle.

TECHNICAL PUBLICATIONS.

The Mechanical World Electrical Pocketbook for 1910. Size, 4 by 6. Pages, 271; figures, 65. Manchester, 1910: Emmott & Company, Ltd. Price, 6d. net.

This pocketbook is issued annually, and each new edition is thoroughly revised and brought up to date. In the 1910 issue large additions have been made to the sections on electric lamps and lighting, and new sections have been introduced on motor converters, carrying capacity of cables, cheap house wiring, conduit system of wiring, etc. The book comprises a useful collection of data for electrical engineers.

The Mechanical World Pocket Diary and Year Book for 1910. Size, 4 by 6. Pages, 391; figures, 67. Manchester, 1910: Emmott & Company, Ltd. Price, 6d. net.

This handy little mechanical engineer's pocketbook is now in its twenty-third edition, and, in addition to the features which have made it popular in previous years, some new material has been added on oil engines and the design of cen-

trifugal pumps. Other additions include such subjects as ball bearings, dimensions of marine boilers, tapers and angles, change wheels for cutting metric pitches, hobs for cutting involute gears, dimensions of ring oil bearings, notes on double helical gears, bevel, spiral and worm gears, emery wheel speeds, etc. Various other tables and data have been introduced and the work revised generally.

Bureau Veritas, 1909-1910, Repertoire General. Two volumes. Size, 10¼ by 11¼ inches. Pages, steamers, 1,125; sailing vessels, 1,047. Paris, 1910: 8 Place de la Bourse, or London, E. C., 155 Fenchurch street. Price, complete, £3 3s. ($15); steamers, £1 15s.; sailing vessels, £1 10s.

This is the fortieth edition of the general list of merchant shipping of all nations issued annually by the Bureau Veritas. The size of the book has been changed this year, making it somewhat more convenient to handle. The tables and contents, however, remain the same as in previous years. The list of steamers includes general statistics of each flag, statistics of steamers built, bought and sold in the principal countries during the year, a list of the steamships of all nations, tables of changes of names, new steamers, etc., a list of steamers carrying petroleum in bulk, a list of cable vessels, an alphabetical list of steamers arranged according to tonnage, an alphabetical list of iron and steel shipbuilders, arranged according to the nationality, an alphabetical list of steamship owners, arranged according to the nationality, with the names and gross tonnages of their steamers, and a list of all drydocks, etc., in all ports of the world. The volume devoted to sailing vessels is arranged in practically the same manner as that for merchant steamers, except that there are separate lists for the owners of wooden vessels and for the owners of steel and iron vessels, and a list of vessels with auxiliary engines.

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SELECTED MARINE PATENTS.

The publication in this column of a patent specification does not necessarily imply editorial commendation.

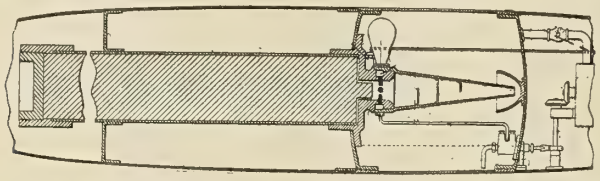
American patents compiled by Delbert H. Decker, Esq., registered patent attorney, Loan & Trust Building, Washington, D. C.

936,632. AUTOMATIC RELEASING DEVICE FOR BOATS. CHARLES HUNT, OF NEW YORK, N. Y.

Claim 1.—A launching device for boats having, in combination, a frame for attachment to a boat, a holding-bar journaled thereon, a locking-block co-operating with the bar, and a tripping-lever having one end in engagement with the frame, the lever and block being combined so as to enable the ene to release the other automatically by jarring the device. Four claims.

937,217. AUTOMOBILE TORPEDO. HUDSON MAXIM, OF BROOKLYN, N. Y.

Abstract.—The invention consists in the method of producing a motor fluid by burning a body capable of supporting its own combustion and employing the products of combustion to heat a liquid which is simultaneously passed through a chamber with the products of combustion, the unevaporated portion of said liquid being again passed through said chamber, where further evaporation takes place, and the unevaporated por-



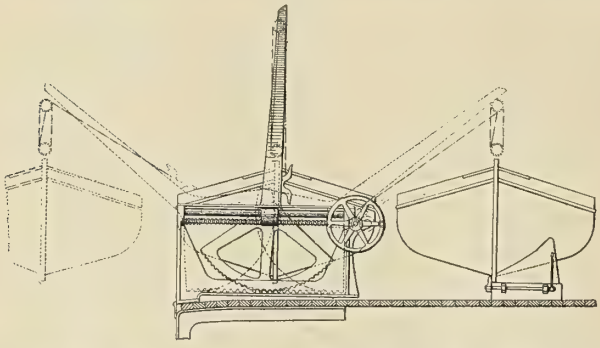
tion of the liquid, with its contained heat, is again circulated through the chamber, and thus continuously to the end that the temperature of the products of combustion is lowered to a point where it will not be injurious to the motor of the torpedo, and the heat is utilized for converting the liquid into steam, which is mixed with the products of combustion to form the motor fluid. Nineteen claims.

937,297. SYSTEM FOR GENERATING STEAM. CHARLES FERO, SR., OF BAY CITY, MICH., ASSIGNOR, BY MESNE ASSIGNMENT, OF ONE-HALF TO IGNATIUS ANDRZEJEWSKI, OF BAY CITY, MICH.

Claim.—An auxiliary steam generating attachment for steam boilers comprising a fluid receiving tank adapted for arrangement in a combustion chamber, means for supplying fluid thereto, a discharge pipe connected at one end to said tank, a perforated pipe connected with the other end of said discharge pipe and of a length sufficient to extend through opposite ends of the boiler to which it is to be applied, a tank adapted to be arranged in the boiler smokestack and connected to one end of said perforated pipe, the other end of said pipe being designed to project outside the boiler and provided with a valve for regulating the fluid supply, a pipe leading from said smoke stack tank into the boiler bent to form connected inverted U-shaped members, the uper portion of said U-shaped members having downwardly opening perforations, the legs thereof having laterally opening perforations and the connecting members having upwardly opening perforations whereby the fluid is forced through the water in the boiler in all directions to facilitate the rapid generation of steam. One claim.

938,447. DAVIT FOR HOISTING AND LOWERING BOATS. AXEL WELIN, OF LONDON, ENGLAND, ASSIGNOR TO WELIN QUADRA&T DAVIT, A CORPORATION OF NEW YORK.

Claim 1.—In a davit for hoisting and lowering boats, the combination of a davit arm having a toothed sector at its lower end, a rack on which



the sector may roll, and means for moving the davit arm to substantially an equal degree of inclination from the vertical in both directions. Fourteen claims.

938,911. PROPELLING MEANS FOR VESSELS. THOMAS B. TAYLOR, OF NEW YORK, N. Y.

Claim 1.—In a boat or vessel the combination of two separate, independently acting engines, two concentric shafts, a direct connection between one engine and one shaft, a direct connection between the second engine and the second shaft, two independent propellers of respectively opposite pitch, one on each shaft, and means for dividing one shaft, stopping one engine and connecting said shafts together. Fifteen claims.

937,433. STEAM-BOILER FURNACE. HENRY GALLAGHER AND GEORGE S. GALLAGHER, OF NEW YORK, N. Y., ASSIGNORS OF ONE-HALF TO SAID HENRY GALLAGHER AND ONE-HLF TO ARCHER P. GALLAGHER, BOTH OF NEW YORK, N. Y.

Claim 1.—In a steam boiler furnace, a boiler, inclosing and supporting walls therefor, grate bars, and a bridge-wall, said bridge wall being provided with an air flue extending across the same, a hopper-shaped recess in the top thereof and forward of the said air flue, a passageway leading from the space beneath the said grate bars to the said air flue, a soot flue leading from the said hopper-shaped recess in the top and to the rear thereof, and a series of apertures leading from the said air flue to the said hopper-shaped recess. Five claims.

British patents compiled by G. F. Redfern & Company, chartered patent agents and engineers, 15 South street, Finsbury, E. C., and 21 Southampton building, W. C., London.

5,370. SCREW PROPELLERS. G. W. MAY, LONDON.

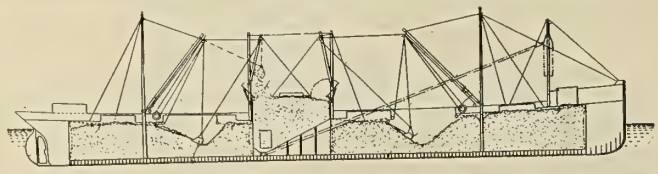
The inventor states that the churning of ordinary propeller blades causes air to be drawn into the water, so producing slip. To obviate this objection he constructs a divided propeller in which the blades are so disposed in respect to each other as to throw the exhaust spray at first quickly through the opening between two consecutive blades and then awash over that portion of the boss which carries the blade next starting on its working stroke. The centrifugal force of the wash causes the water to rush along the face of the blade, and thus to drive away the air which adheres to or is propelled by it.

6,126. PROPULSION OF SHIPS AND THE LIKE. C. DAY, GLASGOW.

The invention consists in the employment, as prime mover, of internal-combustion engines so arranged in conjunction with propellers and clutches and with electric transmission gear comprising a dynamo and motor that the speed of the engine can be controlled over a considerable range in one direction, allowing it to drive directly both at and considerably below the full "ahead" speed of the ship, and to drive electrically when lower speeds and reversing are desired; thus the power or capacity of the electrical gear need only be small relatively to the full speed power of the prime mover. The engine is coupled direct to the dynamo, and by a clutch with the propeller shaft, the motor being placed on the propeller shaft.

27,586. STORAGE VESSELS OR HULKS FOR COAL AND OTHER LOOSE MATERIAL. P. W. SIEURIN, GOTHENURG, SWEDEN.

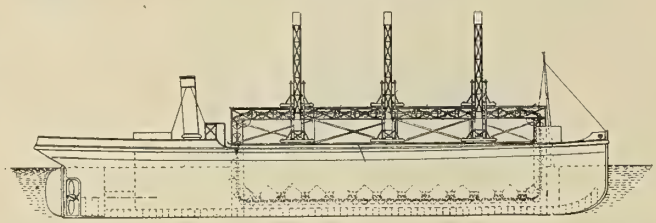
The vessel or hulk is provided with a hopper-like chamber from which the coal can flow to conveyors which carry it to shoots discharging over



the side into the holds of vessels along side, mechanically operated means also being provided for collecting coal from the hold of the storage hulk and delivering it to the hopper chamber ready for delivery.

28,555. COALING STEAMERS. J. MAYOH, WIMBLEDON PARK, SURREY.

The object is to provide a vessel to receive coal, steam to a port where vessels put in for bunker coal and there discharge into the bunkers of such a vessel without bringing it along side a quay, and that entirely without handling the coal. The hold has hopper-shaped pockets; sets of transverse conveyors, a bucket conveyor running partly longitudinally,



partly vertical and fed with coal from the hold by the transverse conveyors. Vertical bucket elevators have selecting mechanism, which feed continuously from the longitudinal conveyor to each elevator and telescopic shoots operating in conjunction. The hopper pockets have controlling doors, so that the trim of the ship can be maintained while discharging. The elevators are movable longitudinally on guides along the vessel, and each is pivoted about a point in its length and capable of motion in a vertical plane.

8,578. PROPELLERS. O. C. JONES, MAIDSTONE.

This construction is for aeroplanes, but the invention is applicable to ships. As the frame of the propeller is rotated from the driving shaft in the direction of the arrows, the blade is, for the first part of the revolution of the frame, at the upper part of the guide grooves, the spring being gradually put into increasing tension as the frame rotates, this graduation being indicated by the broken lines. The blade retains its position in the frame and the tension of the spring gradually increases until the blade just passes a plane containing the axis of the spring, then the tension suddenly pulls the blade to the opposite ends of the grooves, that is, to the ends of the grooves which are now in the upermost position owing to the rotation of the frame.

26,289. SCREW PROPELLERS. C. COMA, MONTMAGNY, FRANCE.

According to this invention, a number of propellers are placed one behind the other on a shaft, blades being arranged in overlapping succession very close behind one another. They are arranged in a helix and so proportioned and arranged with regard to the extent of overlapping that each succeeding blade receives the water current of that preceding without any whirling action. The water current is acted upon so that it passes through the whole helical channel and is all the time acted upon by the different blades without causing whirls, thus enhancing the efficiency. The drawing shows the new propeller arranged at the stem of the ship.